ON THE ORIGINS OF NAMING AND OTHER SYMBOLIC BEHAVIOR

PAULINE J. HORNE AND C. FERGUS LOWE

UNIVERSITY OF WALES

We identify *naming* as the basic unit of verbal behavior, describe the conditions under which it is learned, and outline its crucial role in the development of stimulus classes and, hence, of symbolic behavior. Drawing upon B. F. Skinner's functional analysis and the theoretical work of G. H. Mead and L. S. Vygotsky, we chart how a child, through learning listener behavior and then echoic responding, learns bidirectional relations between classes of objects or events and his or her own speaker-listener behavior, thus acquiring naming—a higher order behavioral relation. Once established, the bidirectionality incorporated in naming extends across behavior classes such as those identified by Skinner as the *mand, tact,* and *intraverbal* so that each becomes a variant of the name relation. We indicate how our account informs the specification of rule-governed behavior and provides the basis for an experimental analysis of symbolic behavior. Furthermore, because naming is both evoked by, and itself evokes, *classes* of events it brings about new or *emergent* behavior such as that reported in studies of stimulus equivalence. This account is supported by data from a wide range of match-to-sample studies that also provide evidence that stimulus equivalence in humans is not a unitary phenomenon but the outcome of a number of different types of naming behavior.

Key words: naming, verbal behavior, language, symbolic behavior, stimulus equivalence, listener behavior, rule governance, speech for self, consciousness, match to sample, children

Within behavior analysis in recent years there has been an upsurge of interest in the study of human behavior in general and, more particularly, in those complex behavioral phenomena that many previously considered to be the exclusive concern of cognitive psychology. Language, or verbal behavior, and its interactions with other behavior are now at the center of a great deal of research, and it is increasingly evident that behavior analysts wish to reclaim the high ground of behavioral complexity and deal with issues such as word meaning, semantic relations, and symbolic behavior (e.g., Catania, 1992, pp. 152–156; Dugdale & Lowe, 1990; Hayes & Hayes, 1992; Lowe, 1983; Sidman, 1990, 1992). But to specify, let alone account for, word meaning and symbolic behavior is not at all straightforward. As Premack (1990) has observed, it has proved to be enormously difficult for the various approaches within psychology and other disciplines to define what a word or a name is and how naming differs from other forms of behavior (see Quine, 1960; Terrace, 1985). Within cognitive psychology, for example, Harnad (1990) has noted that a flaw in the dominant paradigm, in which "the mind is a symbolic system and cognition is symbol manipulation" (p. 336; see also Fodor, 1975), is that it has a "symbol grounding problem" (p. 335; see also Searle, 1980): That is, there is no way of relating the symbols in the system to the real world. In the absence of such a relation, the "symbols" cannot symbolize or mean anything—a serious flaw by any account.

The central aims of the present paper are thus ambitious. They are (a) to specify the basic unit of verbal behavior, or language, which we identify as the *name* relation, and (b) to show how this behavioral unit is learned and comes to *symbolize* objects and events in the real world (cf. Harnad, 1990). Our account builds upon that of Skinner's *Verbal Behavior* (1957), although Skinner, while acknowledging that *names* differ from *tacts,* did not himself use *naming* as a technical term. The term now features prominently in the behavior-analytic literature, but seldom, if ever, in the context of any behavioral specification of what it is. We aim not only to

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Correspondence and requests for reprints should be addressed to either Pauline Horne or Fergus Lowe, School of Psychology, University of Wales, Bangor, Gwynedd, LL57 2DG, United Kingdom.

provide a behavioral specification that will help to standardize use of the term in the literature, but also to present a functional analysis of how naming comes about from early infancy onwards, and then, once it is established, how it affects, and is in turn affected by, other behavior.

There are problems inherent in using the term *naming*, laden as it is with connotations from existing usage in behavior analysis, other science areas (e.g., psycholinguistics, developmental psychology, cognitive psychology) and, of course, everyday life itself. But there are also considerable advantages. An effective behavioral specification of naming and how it comes about would, if generally accepted, not only advance behavior analysis but might also foster productive interaction with scientists from other traditions who, although they may frequently refer to naming, nevertheless are constrained by the lack of a fundamental and specific behavioral underpinning to its usage. Thus, although we are mindful that our readers will need to hear *naming* as we specify it and will have to ignore misleading connotations from other contexts, we have nevertheless chosen the term *name* to indicate the basic verbal unit.

In recent times many of the innovative ideas within behavior analysis about how verbal behavior should be characterized have come from researchers working in the area of what has been termed *stimulus equivalence*. To understand how this research relates to linguistic issues it may be helpful to consider some pioneering work by Murray Sidman, who used "symbolic" match-to-sample procedures to teach conditional discriminations to youths with mental retardation (Sidman, 1971; Sidman & Cresson, 1973). The general procedure is illustrated in Figure 1 which shows that subjects first learned to select (or demonstrated that they were already able to select) a particular comparison stimulus (e.g., picture of a car) upon hearing a dictated word (e.g., "car"). This performance, which was repeated for many spoken word-picture relations, is shown as an AB relation in Figure 2. Subjects were next taught (upper right of Figure 1) to select printed words (e.g., CAR) upon hearing the corresponding spoken words (e.g., "car"), shown as AC in Figure 2.

Establishing such conditional relations with match-to-sample procedures was not of course new and had previously been demonstrated with many animal species, but Sidman and colleagues found when further testing their subjects that entirely new untrained behavioral relations *emerged*; these relations were not predicted by known laws of learning. Thus, when presented with the printed words (e.g., CAR; lower left, Figure 1), subjects selected the corresponding picture (e.g., of a car) and when presented with the picture they selected the corresponding printed word (lower right, Figure 1). These emergent relations are shown in Figure 2 as CB and BC, respectively. Following the establishment of 40 trained relations (20 AB and 20 AC), 40 new relations (CB and BC) were present when tested. Sidman has described the emergent performances (CB and BC) as *equivalence relations* and has argued that these results show that *stimulus equivalence* had been established between the three stimulus members of each class (i.e., the auditory name stimulus, the corresponding printed word, and the corresponding picture). Over the two decades that have passed since these studies, their findings have been replicated and extended with human subjects of varying ages and with differing stimulus modalities and types of match-to-sample procedures (see Saunders & Green, 1992; Sidman, 1994).

Describing these behavioral outcomes of match-to-sample procedures as stimulus equivalence had very important implications for subsequent research in this area. In two key papers, Sidman and colleagues (Sidman et al., 1982; Sidman & Tailby, 1982) argued that the concept of equivalence as used in mathematics could be applied to performance on conditional discrimination tasks in ways that would bring methodological rigor to the definition and identification of "behavioral" equivalence. The three defining characteristics of mathematical equivalence (i.e., reflexivity, symmetry, and transitivity) were, accordingly, borrowed and applied to behavioral relations. Thus, according to the theorists who have been most influential in this area, the property of *reflexivity* (e.g., A = A) is inferred from match-to-sample performance when subjects show generalized identity matching; *symmetry* is inferred when, having trained subjects to select Stimulus B upon presentation of Stimulus A (i.e., an A-B relation), the subjects proceed without further

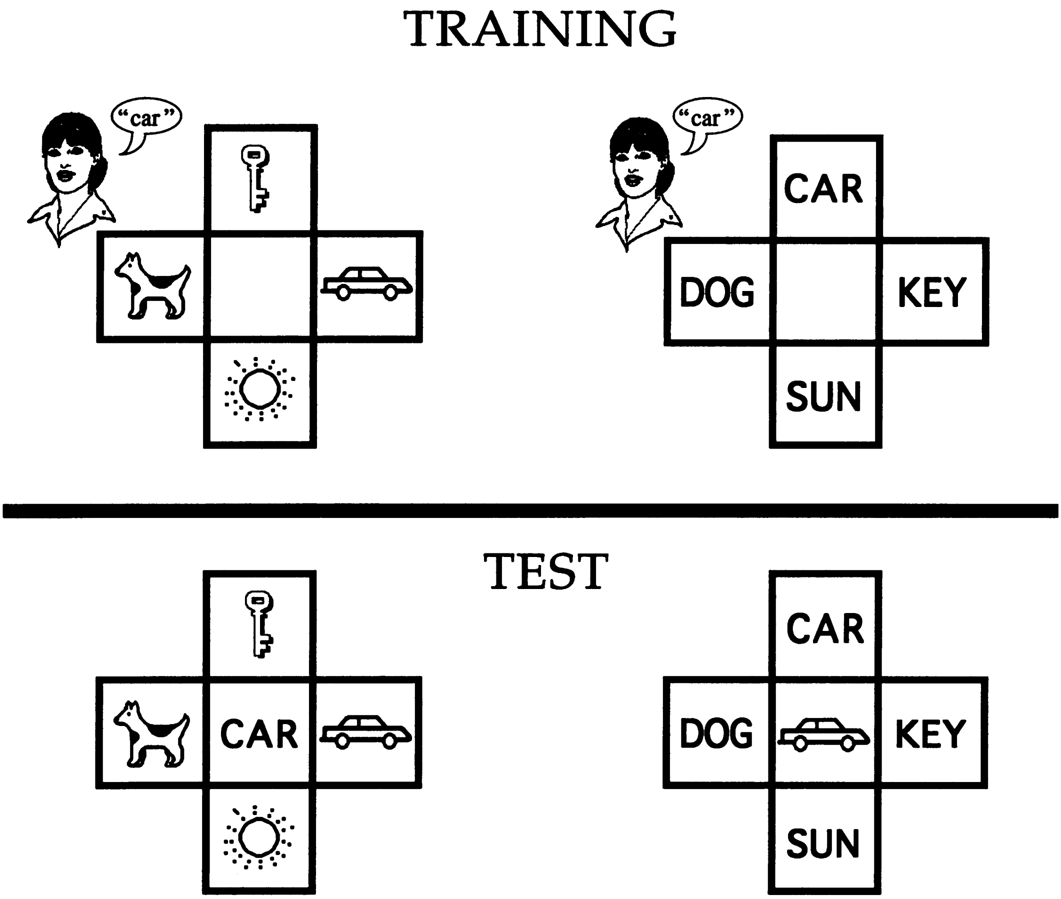

Fig. 1. An example of a match-to-sample procedure (see Sidman, 1971). This shows a five-key response panel; during training (top) the sample stimuli are dictated words and the comparison stimuli are visual stimuli (pictures or words). At the start of each trial, the sample (e.g., the dictated word "car") is presented via tape recorder; touching the center key then brings on the comparison stimuli on the outer keys. Reinforcers are delivered for selecting the stimulus that corresponds to the sample (e.g., the picture of a car or the printed word CAR). In test trials (bottom) the printed words (e.g., CAR) or the picture (e.g., of a car) are presented as samples. Stimulus equivalence is demonstrated when, in the absence of reinforcement, the corresponding comparison picture is selected when the printed word is the sample, and vice versa.

training to select A when presented with B (i.e., B-A); *transitivity* is inferred when, having established A-B and a second relation B-C, subjects proceed without further training to select C when presented with A. When subjects show evidence of meeting all three criteria with a given set of stimuli (e.g., A, B, and C in the above example), then it is concluded that all of the behavioral relations among the stimuli, even those that have been trained, are in fact equivalence relations and that the stimuli concerned form an equivalence class.

The introduction of the mathematically based concept of equivalence brought together these different behavioral relations under a common name and gave rise to the notion that there was a unitary psychological phenomenon called stimulus equivalence that could be assayed using match-to-sample procedures. In addition, what had been a number of different *dependent* variable measures on match-to-sample tasks were now viewed as measuring a single *determining* variable—namely equivalence—that purportedly gives rise to a range of linguistic phenomena that have puzzled psychologists, psycholinguists, and philosophers for many years. Thus, Sidman, for example, has argued that stimulus equivalence is a linguistic prerequisite (Sid-

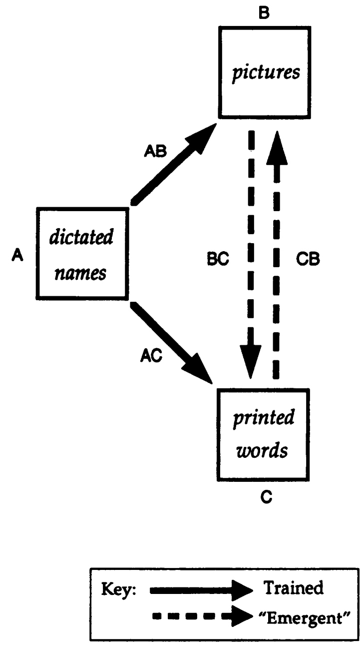

Fig. 2. A schematic representation of Sidman's (1971) equivalence paradigm. The arrows point from sample to comparison stimuli. The solid arrows represent conditional relations (AB and AC) that were explicitly taught. Broken arrows represent conditional relations (BC and CB) that were tested for after the others had been explicitly taught.

man, 1986, p. 226), and is a determining variable that accounts "both for what people say and for their reactions to what other people say. In particular the existence of equivalence relations can account for such utterances as 'meaning,' 'symbol,' 'referent,' and 'rule-governed' " (Sidman, 1992, p. 20).

Hayes and colleagues, although adopting a different theoretical stance from that of Sidman, have similarly acknowledged the importance of the phenomenon and have maintained that stimulus equivalence "transforms nonlinguistic conditional discriminations into semantic process" (Wulfert & Hayes, 1988, p. 126) and is "a kind of working empirical model of semantic relations" (Hayes & Hayes, 1992, p. 1387). Still others have proposed that equivalence classes define symbolic behavior and that the stimulus equivalence paradigm provides the basis for an experimental analysis of symbolic behavior (e.g., Catania, 1992, p. 156; Dugdale & Lowe, 1990, p. 115).

If these propositions—namely, that stimulus equivalence is a key variable that transforms nonlinguistic into linguistic behavior, that it is the test of whether relations are semantic, and that it is, indeed, the defining property of symbolic behavior itself—were to be accepted, then this would have major repercussions for attempts to explain language. This, of course, would include Skinner's account of verbal and rule-governed behavior, which does not incorporate the construct of stimulus equivalence. For those wishing to study linguistic or verbal behavior, what is at issue here is a specification of the subject matter itself. When can we say of an utterance, for example, that it is not simply an instance of operant behavior but that it also has properties that enable us to say that it is a "word" or "name" and that it has "meaning"? For some (e.g., Hayes & Hayes, 1989, p. 182), Skinner's definition of verbal behavior as behavior reinforced through the mediation of other persons in accordance with the practices of the verbal community is too broad and fails to distinguish it from any other learned social behavior; for these critics it is equivalence that provides the true touchstone enabling us to specify when behavior is verbal. Because it lacked an appreciation of stimulus equivalence, Skinner's theory of verbal behavior, they argue, ignored such issues as meaning, understanding, and reference and, ultimately, failed to grasp the essential nature of verbal behavior (Hayes & Hayes, 1989, p. 154, 1992, p. 1392). Furthermore, both Sidman and Hayes maintain that the absence of the concept of equivalence from Skinner's account undermines his attempt to distinguish between contingency-shaped and rule-governed behavior, a distinction many would see as one of the most important advances in the analysis of human behavior (Devany, Hayes, & Nelson, 1986, p. 255; Hayes & Hayes, 1992, p. 1392; Sidman, 1990, pp. 106–107, 1992, pp. 21–22; Zettle & Hayes, 1982).

Can it be then, as the "equivalence critique" might suggest, that Skinner's theory of verbal and rule-governed behavior is a case of "Hamlet without the Prince"? Before the critique and the proposed solutions can be adequately assessed, however, it is necessary to examine the notion of stimulus equivalence itself and emerging problems in the literature concerning its definition (Hayes, 1989; Pilgrim & Galizio, 1995; Saunders &

Green, 1992) and its origins (Catania, Horne, & Lowe, 1989; Dugdale & Lowe, 1990; Hayes & Hayes, 1992; Sidman, 1994). There are also a number of related issues including the fact that humans, at least those with some verbal skills, readily pass tests of stimulus equivalence whereas there are few, if any, clear demonstrations of stimulus equivalence in other animal species (Dugdale & Lowe, 1990; Hayes & Hayes, 1992; Sidman et al., 1982).

Attempts to deal with these issues have come from three main theoretical perspectives. According to Sidman and colleagues, stimulus equivalence is an unanalyzable primitive function that, Sidman suggests, we may simply have to accept as a biological "given" (Sidman, 1990). In order to overcome what they see as the shortcomings of Sidman's account, Hayes and colleagues (Hayes, 1986; Hayes & Hayes, 1989) have introduced *relational frame theory,* which views equivalence as one of several relations arising from a history of arbitrarily applicable relational responding. Lowe (1986)[1] has put forward a third view according to which success on match-to-sample tests of stimulus equivalence is attributable in large part to subjects' naming and other verbal behavior, thus explaining the lack of success of nonverbal organisms on these tests (see also Dugdale & Lowe, 1990; Lowe, Horne, & Higson, 1987). Critics of this latter approach, however, have rightly observed that if naming is a prerequisite for passing tests of equivalence, one is left with the problem of accounting for how naming itself comes about and how it gives rise to what appear to be emergent or derived stimulus relations (Catania et al., 1989; Hayes, 1994; Hayes & Hayes, 1992; Sidman, 1990, 1992). In what follows we shall attempt to show how naming, although differing from other forms of operant or classically conditioned responding, arises out of particular relations between such behavior and the environment. We shall also address how naming can enable human subjects to succeed on match-to-sample tests for stimulus equivalence and how these tests may be passed with several types of naming behavior, giving rise to not one but a variety of psychological "equivalences."

Our general approach owes much to Skinner's *Verbal Behavior* (1957) but attempts to extend that account in a number of ways. Central to our analysis is an emphasis on listener behavior and a conceptualization of the individual as a *speaker-listener* within the same skin. This early involvement of the young child as a listener, first to others' utterances and then, even more important, to his or her own, is an aspect of verbal behavior that is to a large extent not addressed in Skinner's book, at least in his account of the basic verbal classes (see Hayes & Hayes, 1989). As he himself observed, "Most of my book . . . was about the speaker. It contained . . . little direct discussion of listening" (Skinner, 1989, p. 36). Indeed, insofar as his definition of verbal behavior as "being effective only through the mediation of other persons" is taken literally, then the effects of what the speaker says upon his or her own behavior as a listener, in the absence of any other person, could be deemed nonverbal behavior! (but see also Skinner, 1989, pp. 46–47). Certainly, in all of his writings on verbal behavior Skinner says comparatively little about speaker-listener relations and particularly of how they come about. In what follows we shall attempt to provide such an account and will argue that it is only through an analysis of both speaker and listener behavior that we can establish what counts as an instance of a name, how the latter comes to have *meaning* and, in short, what constitutes linguistic or verbal behavior distinguishable from other forms of conditioned responding.

To illustrate our general approach and to indicate how speaker-listener relations can account for a range of emergent behavior including stimulus equivalence, consider the different behavioral relations embodied in the concepts of the *tact* and the *name.* Skinner (1957) defined the tact relation as "a verbal operant in which a response of a given form is evoked (or at least strengthened) by a particular object or event," this correspondence between the object (e.g., a car) and the particular form of responding (e.g., saying "car") being established by generalized reinforcement from the verbal community (pp. 81–82). Although tacting is sometimes viewed, erroneously, as being the same as

[1] Lowe, C. F. (1986, May). *The role of verbal behavior in the emergence of equivalence classes.* Paper presented at the annual meeting of the Association for Behavior Analysis, Milwaukee.

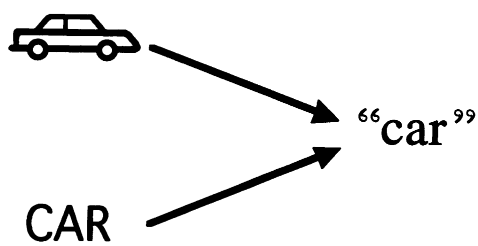

Fig. 3. The tact relation (Skinner, 1957) occurs when a response of a given form (e.g., saying "car") is evoked in the presence of a particular object (e.g., a picture of a car). According to Skinner's account, if the stimulus that evokes the response (e.g., "car") is written or printed (e.g., the printed word CAR) then, strictly speaking, the verbal relation is a *textual* rather than a tact (although this distinction is not easy to sustain because, e.g., a picture may also be drawn or printed). When, as in the figure, the picture and printed word both evoke the same vocal response (i.e., "car"), this is termed *functional equivalence.*

naming, it does not, as defined, encompass any form of listener behavior on the part of the speaker, and cannot, by itself, account for "emergent" behavior. For example, Figure 3 shows what would have occurred had the subjects in the studies by Sidman (1971) and Sidman and Cresson (1973) tacted the stimuli in each of the experimenter-designated stimulus classes. Each of the stimuli (e.g., picture of a car and the printed word CAR) would be discriminative for a common response (in this instance, the utterance "car"), a relation that is termed *functional equivalence* (Goldiamond, 1966; Sidman, 1986). But, given the unidirectional nature of the tact relation, there are no grounds for assuming that this should give rise to bidirectional relations and stimulus equivalence (i.e., that if given the picture of a car, the subject would select the word CAR, and vice versa). Neither tacting nor functional equivalence in and of itself should give rise to stimulus equivalence.

The name relation, on the other hand, which we describe in detail in the next section, involves the speaker responding as a listener to his or her own speaking. Naming, as it is learned by the young child,[2] is thus a circular relation (shown in Figure 4, top) that includes, for example, *seeing* an object (e.g., picture of a car), *saying* ("car"), hearing her own utterance (*/car/*)[3] and *seeing* or otherwise attending to the object again. When, like the subjects in the Sidman studies, individuals with naming skills are trained on match-to-sample procedures to select first a picture (e.g., of a car) and later the corresponding printed word (CAR) upon hearing the name (*/car/*) spoken by the experimenter, this provides ideal conditions for them to learn the name themselves for both the picture and the printed word. When, as shown in Figure 4 (bottom), the picture is then presented as a sample, the subject either overtly or covertly says the name, the hearing of which is discriminative for orienting to and selecting either the printed word or the picture from among the comparisons, whichever is presented, and vice versa when the sample is the printed word. Thus subjects may succeed in passing tests of stimulus equivalence by using a common name for the stimuli in each class. We shall show that other naming strategies, in particular, such as relating the stimuli by means of intraverbal naming, may also be successful in establishing equivalence classes.

Our perspective, although grounded in Skinner's analysis of verbal behavior, is also informed by accounts of naming and language development provided by L. S. Vygotsky and by the social behaviorist G. H. Mead (see Blackman, 1991). Our exposition of the genesis of ontogenetically early forms of linguistic behavior, including the behavioral precursors of naming as well as naming itself, draws heavily upon, and is underpinned by, a great deal of empirical research from the recent literature on language development in young children. In dealing with normal language development over the first 2 years of life up to the point when intraverbal strings of a few names have been learned, we aim not to provide an exhaustive description but to show the critical steps necessary to bring about the name relation. It is also important to note that what we are proposing, with respect both to the order in which these forms of behavior occur and the conditions that influence them, is an hypothesis that, although based on a range of existing findings, re-

[2] For purposes of illustration here and in the rest of the paper, we shall take as an example a young female child without sensory impairment who is learning language.

[3] To distinguish spoken from heard utterances we shall indicate the former as, for example, "car" and the latter as */car/*.

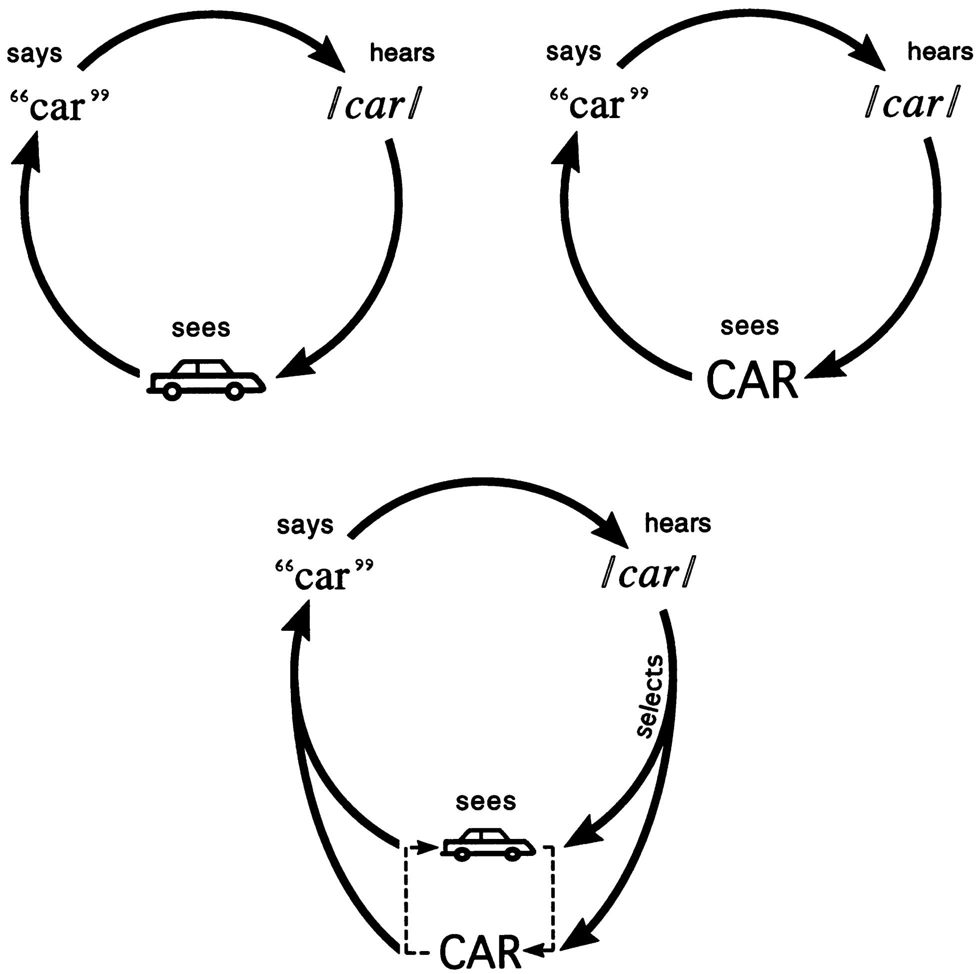

Fig. 4. Schematic representation of the name relation and the role of common naming in auditory-visual match to sample. The name relation involves speakers responding as listeners to their own speaking and is shown here (e.g., top left) as a circular relation between seeing an object (picture of a car), saying ("car"), hearing their own utterance (*/car/*), and seeing or otherwise orienting to the object again. During training on match to sample (cf. Sidman, 1971), shown in the upper displays, when the subject hears the auditory sample stimulus (*/car/*), she echoes it (saying "car") in the presence of the corresponding visual comparison (picture of a car or printed word CAR), and a common name is thereby established. During subsequent visual-visual test trials (bottom), seeing either the picture of a car or the printed word CAR as the sample evokes the saying of "car" and the hearing of */car/*, which in turn occasions selecting either the corresponding picture or printed word, whichever is available as comparison.

quires further detailed empirical validation. We shall also show how the present analysis informs a range of issues concerning rule-governed and what has been termed *symbolic* behavior. A secondary aim of the paper is to show how naming skills can account for the success of subjects on tests of stimulus equivalence and in a manner that may render theories of *equivalence,* and, indeed, the construct itself, redundant.

THE DEVELOPMENT OF VERBAL BEHAVIOR

In attempting to show how naming develops from earlier, prelinguistic behavior, we shall relate our account to some of the basic verbal classes identified by Skinner (1957), in particular the tact, echoic, intraverbal, and mand. Skinner defined these classes within the framework of the three-term contingency (i.e., discriminative stimulus, response, reinforcer) but argued that one of the main distinguishing features of verbal behavior was that, with the exception of the mand, it was free of specific reinforcing consequences. For example, a child's saying "cat" in the presence of a cat could be reinforced by any of a variety of reinforcers (e.g., the caregiver saying "yes it is a cat," "clever girl," etc.). The behavioral modalities were also unspecified in his account; individuals may learn verbal behavior regardless of whether they are able to hear, see, or speak. Although for purposes of illustration the present paper focuses upon the development of verbal behavior in a child who is without sensory handicap, the main principles of our account apply also to people who are deaf, blind, or have other sensory impairments, because other responding apart from vocalizing (e.g., manual signing) can function as *speaker behavior* (e.g., Hall & Sundberg, 1987). Again for explanatory purposes we have focused upon behavioral interactions between the child and her primary caregivers, although we recognize that others (e.g., siblings, friends, relatives) will also form part of the child's verbal community.

Listener Behavior

There is an extensive literature that shows how, before they learn to speak, children learn to listen, as illustrated, for example, by a caregiver saying to a child, "give me the cup" and the child doing so. Such behavior, which has been termed *listener behavior* by Skinner (1957, p. 357), arises when the verbal community, of whom we will take the caregiver to be representative, establishes a correspondence between a vocal or other conventional stimulus produced by a speaker and behavior evoked in the listener. It includes classically conditioned behavior such as "responses of glands and smooth muscles, mediated by the autonomic nervous system, especially emotional reactions . . . [as well as] . . . complex skeletal behavior with which the individual operates upon [the] environment" (Skinner, 1957, p. 34). However, according to Skinner's definition of verbal behavior, listener behavior is not verbal except "when the listener . . . [is] . . . to some extent speaking" (1989, p. 36). Consequently, this phase of the child's development is given little consideration in his account. In the present analysis, however, we consider the learning of listener behavior to be a crucial precursor to the development of linguistic behavior and will therefore describe it in some detail.

The conditions under which listener behavior is established in the young child normally include the following: (a) The caregiver or others produce a vocal stimulus, usually an object name, in the presence of the object and the child; (b) concurrently, using social reinforcement, caregivers teach the child how to perform conventional behavior in relation to the object; (c) rather than her speech simply accompanying the child's behavior, the caregiver's vocal stimulus increasingly precedes and becomes discriminative for the child's performance of this object-related conventional behavior. These conditions are met through a series of behavioral interactions between caregiver and infant, as illustrated below.

Discriminating the speech of others. If the speech of others is to provide effective controlling stimuli for the behavior of the young child, it is essential that this speech and its component parts (i.e., individual words) be discriminated by the child. This process begins very early in life. Molfese (1977), for example, reported that when speech sounds are presented to the human neonate, neural activity is greater in the left cerebral hemisphere than in the right; when, on the other hand, music is presented, the converse pattern of activity occurs. A number of studies using operant procedures have also shown that in the first few days the human infant not only discriminates speech sounds from other sounds but also learns to discriminate the speech sounds of her native language from those of other languages (Mehler et al., 1988; Morse, 1972). Studies have also shown that at this early stage, speech sounds are more reinforcing for the child's behavior than are nonspeech sounds (Butterfield & Siperstein, 1972), and that her mother's speech is more reinforcing than that of a stranger (DeCasper & Fifer, 1980). Although young infants can discriminate a range of phonetic contrasts made in natural languages, by around 12 months old their discriminative success becomes more confined to the subset of speech sounds within their native language (Aslin, Pisoni, & Jusczyk, 1983; Eilers, Wilson, & Moore, 1977; Eimas, 1974a, 1974b, 1975; see Gerken, 1994, for recent review).

There is a great deal of evidence that shows that children's learning to discriminate others' speech is aided by the particular ways in which caregivers speak to them (see Richelle, 1993). In general, caregivers (a) speak slowly (Snow & Ferguson, 1977); (b) use single names for objects and actions, which are embedded, if at all, in a simplified syntax (e.g., "give mummy car"; see Cross, 1977; Newport, Gleitman, & Gleitman, 1977); (c) repeat names and simple instructions many times (Snow, 1977); and (d) often accentuate single names and grammatical boundaries by speaking with a higher pitch and more exaggerated intonational patterns than when addressing older children and adults (Cooper & Paccia-Cooper, 1980; Mehler, Bertoncini, Barriere, & Jassik-Gerschenfeld, 1978; Stern, Spieker, & MacKain, 1982). These adaptations of adult verbal behavior, which simplify speech stimuli and make them more salient to children (similar in some respects to stimulus fading procedures used in operant discrimination studies), are widespread crosscultural features of caregivers' speech (Fernald, 1992). In addition, operant techniques have shown that in the case of 4-month-old infants, "motherese" is a more effective reinforcer than other forms of adult speech (Fernald, 1985).

If listener behavior to the speech of others is to become fully established, however, it is necessary not just for speech stimuli to be discriminated (i.e., controlling differential responding of some sort) but when a particular verbal stimulus is heard (e.g., */where's mama?/*) it should be discriminative for conventional object- or event-related behavior (e.g., looking at mama). There are a number of ways in which such behavior is brought about.

Caregivers observe what the child is looking at before they name it. Several studies have shown that caregivers often first observe which object or event an infant is already looking at or otherwise engaged with before they speak about it and reinforce the infant's attention to it (Collis, 1977; Collis & Schaffer, 1975; Cross, 1977; Harris, Jones, Brookes, & Grant, 1986; Harris, Jones, & Grant, 1983; Leung & Rheingold, 1981; Masur, 1982; Murphy, 1978). Tomasello and Farrar (1986) have found that when caregivers make such observations of the child's behavior prior to speaking, it enhances the child's subsequent learning of listener behavior.

Caregivers indicate the object or event that they name. Caregivers also often look at, point to, and otherwise indicate (e.g., by shaking a rattle) the object or event that they are naming. By the time they are about 9 months old, human infants learn to discriminate the behavior of the caregiver and to orient toward the object or event at which the caregiver is looking or pointing; this is learned first for objects that are close at hand and later for objects that are at some distance (Butterworth & Cochran, 1980; Butterworth & Grover, 1988; Lempers, 1976; Messer, 1978). Studies by Baldwin (1991) have shown that the learning of this skill of "joint regard" increases the likelihood that the name produced by the caregiver will in turn become discriminative for the child's looking only at the object at which the caregiver is looking or pointing rather than at other stimuli.

The child points at objects and events. After she has learned to follow the point gestures of others, the child herself begins to point to objects and is socially reinforced for doing so (Foster, 1979; Lempers, Flavell, & Flavell, 1977; Leung & Rheingold, 1981; Masur, 1982; Murphy, 1978; Murphy & Messer, 1977; Ninio & Bruner, 1978). Initially, she learns to point to a particular object, then to the caregiver and to the object again; later she learns to point to an object while at the same time looking at the caregiver (Bates, Camaioni, & Volterra, 1975; Masur, 1983). Her pointing at objects is, in turn, discriminative for caregivers' naming of them, which also reinforces the child's behavior. Further naming opportunities are provided when the young child picks up or gives objects to caregivers, a common behavior in infancy (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Bruner, 1977; Foster, 1979; Gray, 1978).

Caregivers model conventional behavior. In addition to pointing at objects when they name them, caregivers also pick them up and model conventional ways of behaving toward them and reinforce the infant's imitative behavior (Kaye, 1982, pp. 70–83). Infants directly imitate many of these types of modeled behavior even when the opportunity to imitate is deferred (Meltzoff, 1988; Poulson & Kymissis, 1988); thus, generalized imitation enables learning of conventional behavior to proceed rapidly. If there are kinds of behavior that the child is initially unable to imitate, these may be manually prompted and shaped by caregivers (Kaye, 1982, pp. 80–82; see Skinner, 1953, pp. 119–122).

From this point onwards, the child's reactions to objects and events become increasingly conditioned by her verbal community. Whereas previously she may have investigated quite disparate objects (e.g., a toy truck or a shoe) in very similar ways (e.g., grasping, transferring them from hand to hand, raising them to her mouth), between 12 and 18 months of age her actions become differentiated and specific to particular objects (Fenson, Kagan, Kearsley, & Zelazo, 1976; Hutt, 1967). For example, whenever she now sees a toy truck she may load it with bricks and push it along, and when she sees shoes, she may put them on and march up and down in them, and so on. Increasingly, therefore, objects come to occasion particular sequences of socially conditioned behavior, many of which are destined to come under the control of the caregiver's utterances during the establishment of listener relations (Gelman & Baillargeon, 1983; Nelson, 1973; Ricciuti, 1965; Starkey, 1981; Sugarman, 1982).

Caregivers reinforce conventional listener behavior to vocal stimuli. When the child has learned to respond to objects in conventional ways, such as pointing at them, picking them up, and giving them to others, the caregiver may, for example, ask her to "bring shoe" and may model appropriate behavior by pointing to, reaching for, and picking up the shoe. When the child, imitating the caregiver's actions, reliably brings the shoe in response to "bring shoe," the caregiver begins to fade his or her own point-and-reach gestures while reinforcing the child's correct responses by saying "clever girl," putting the shoe on the child's foot, and so on. Eventually, when the caregiver simply says, "bring shoe," the child reliably fetches it and this behavior is reinforced. At this stage the caregiver's vocal stimulus has gained discriminative control of the child's shoe fetching: The child has acquired listener behavior.

An illustration of listener behavior. Figure 5 presents an example of listener behavior in the young child; this is the first one of the three main behavioral relations that together make up the name relation depicted in Figure 4. Figure 5 shows what happens when a caregiver sees a shoe (START 1), points to it, and says to the child, "where's shoe?" (with an emphasis on "shoe"); this request generates for the infant the auditory stimulus */where's shoe?/*, which is a discriminative stimulus (S^D) for looking at or otherwise orienting (R_O) to the shoe; this behavior is, in turn, discriminative for pointing to the shoe (R_X). The child may show additional forms of conventional listener behavior (e.g., putting the shoe on her foot, handing it to the caregiver, etc.) that also provide reinforcing consequences for her orienting to the shoe. The caregiver responds by saying "good girl," which serves to selectively reinforce (S^R) the child's listener behavior that corresponds with the caregiver's request. It is also possible that the caregiver's request may come to serve as a conditioned stimulus (CS) that elicits a range of classically conditioned responses (CRs). As Skinner (1953) observed, a child may "see X not only when X is present, but when any stimulus which has frequently accompanied X is present. The dinner bell not only makes our mouth water, it makes us see food. In the Pavlovian formula we simply substitute 'seeing food' for 'salivating' " (p. 266). In addition, it should be noted that Skinner (1953, pp. 270–276, 1957, p. 158) speculated that there may also be operant visualizing or "seeing" of objects when they are not present. An experimental demonstration of conditioned "hearing" of stimuli when they are not present is provided in a study by Hefferline and Perera (1963).

This listener behavior sequence, beginning at START 1, may be repeated many times until "where's shoe?" alone, without the caregiver pointing, occasions the child's orienting to the shoe. Eventually, the sequence may also begin with the child's behavior rather than the caregiver's. For instance, when the child next sees a shoe (START 2), she may immediately point to it, and when the caregiver sees the child's point gesture, he or she may initiate the caregiver-speaker/child-listener behavior sequence (from START 1). Initially, the listener behavior occasioned by caregivers' speech may also be partly controlled by other contextual stimuli. So, when asked "where's your shoe?" the infant may point at her shoe when it is in her mother's hand but not when it is on the floor. However, with repetition in different contexts,

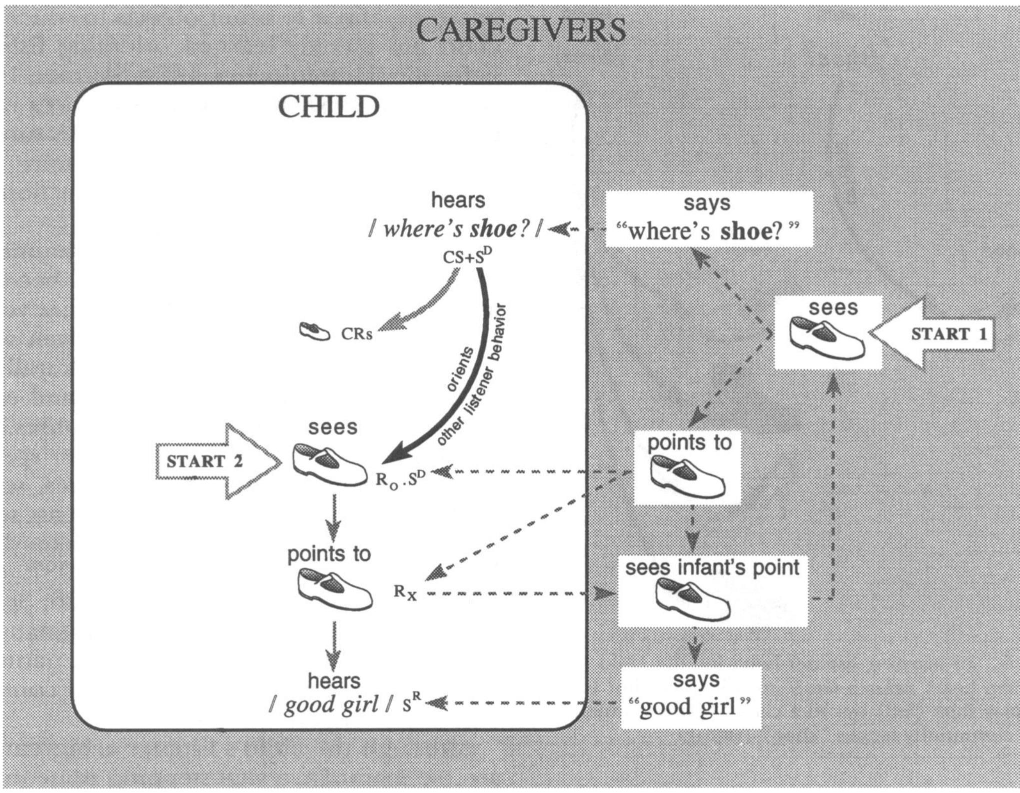

Fig. 5. A schematic account of how listener behavior (solid arrows) is learned by the child during interactions with her caregiver (broken arrows). The sequence begins (START 1) when the caregiver points to and names a shoe, saying "where's shoe?" (with an emphasis on "shoe"). When the child hears */shoe/*, this occasions (S^D) listener behavior, including orienting (R_O) and other conventional responding to the shoe such as pointing to it, putting it on, and so forth (R_X). Hearing */shoe/* may also serve as a conditioned stimulus (CS) evoking conditioned responding (CRs) such as visualizing a shoe. The caregiver reinforces (S^R) the child's conventional listener behavior to "where's shoe?" by saying "good girl." A similar sequence may also come to be initiated by the child first seeing the shoe (START 2) and pointing to it (see text). The black arrow constitutes the listener element of the name relation depicted in Figure 4.

"where's your shoe?" acquires generalized control over the infant's pointing at the shoe regardless of the shoe's location or the particular speaker (Bates et al., 1975; Luria, 1982, pp. 46–47; Reich, 1976; Snyder, Bates, & Bretherton, 1981). Similarly she learns to respond to the utterance "where's shoe?" (or just "shoe" alone) spoken by any of a variety of speakers, each of whom produces sounds of varying pitch and of varying phonetic characteristics (see Luria, 1982).

Listener behavior and stimulus classes. Although Figure 5 depicts one particular shoe, in practice caregivers will use the term *shoe* for a variety of shoes and illustrations of shoes. So when asked "where's the shoe?" the infant may come to point at any shoe in her vicinity irrespective of its color or size, or whether it be her own shoe, a sports shoe, a sandal, a picture of a shoe in a magazine, or perhaps even a horseshoe. If she overextends the stimulus class by pointing to a sock she may be told, "no, not shoe, sock," the usual social praise being withheld; conversely, if the caregiver notices that she underextends the class by not pointing to an item the culture would call a "shoe," that item may be indicated to her and named as such (but see Huttenlocher & Smiley, 1987). Thus, as shown in Figure 6, the infant learns when she hears */shoe/* to orient not just to a particular shoe (left) but to a class of objects (right), membership of the class being established by her caregivers who name each of the different exemplars "shoe."

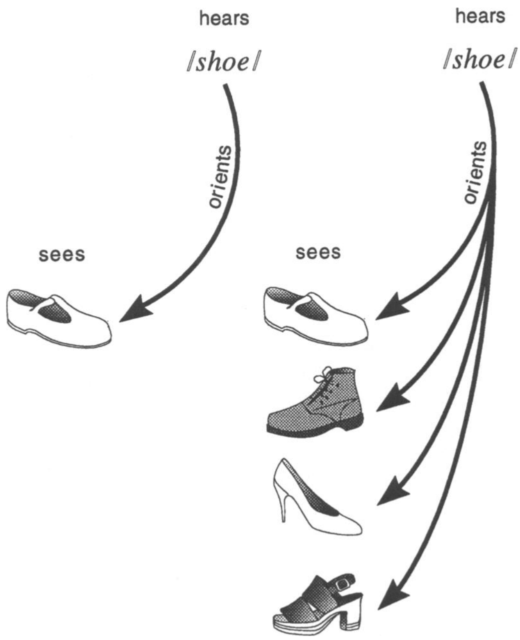

Fig. 6. In learning listener behavior, the child learns when she hears */where's shoe?/* to orient not just to one particular shoe (left) but to a class of objects which her verbal community names "shoe" (right).

In this manner the child begins to learn a series of relations, shared with others in her verbal community, between auditory stimuli produced by others and her own responding to classes of stimuli. It is these particular stimulus classes that she will later learn to name (Harris, Yeeles, Chasin, & Oakley, 1995).

Extension of the listener repertoire. There are more rapid ways of extending listener behavior than that shown in Figure 5. Once the child learns to orient to a shoe when she hears */where's the shoe?/*, to a cup when she hears */where's the cup?/*, and so on for a variety of objects, the first part of the caregiver's verbal stimulus, */where's the . . . /* comes to occasion a particular form of orienting behavior (e.g., pointing), whereas the second part determines the object to which orienting occurs. The caregiver may now add other forms of listener behavior to the child's repertoire by, for example, teaching the child to pick up a shoe in response to her instruction "pick up shoe" and to pick up a spoon in response to her instruction "pick up spoon." Then, when the caregiver says for the first time "pick up cup," the child may pick up the cup, because the listener behavior of picking up has generalized to other objects to which the child has already learned orienting listener behavior (Huttenlocher, 1974; Skinner, 1953, pp. 93–95, 1957, p. 189). This ensures rapid generalization to all objects that feature in the child's existing listener repertoire and further develops the child's instruction-following repertoire.

In the course of these early developments, the child's listening to vocal stimuli becomes increasingly consonant with that of her verbal community. When others utter a given word or set of words, she orients to a culturally established class of objects or events and emits a culturally defined set of responses. Although it has been shown that other species (e.g., dolphins, parrots, chimpanzees, sea lions) can be taught to perform at least some of these listener skills (Herman, Richards, & Wolz, 1984; Pepperberg, 1983, 1987; Premack, 1970; Savage-Rumbaugh, 1986; Schusterman & Krieger, 1984), unless humans intervene, nonhuman animals do not naturally exist in the environmental or social contexts that might enable them to do so.

Although the child's listener achievements are, we maintain, a vital stepping stone in the acquisition of verbal behavior, what distinguishes and delimits this stage of development is that it is others' speaking that determines when and where her listener behavior occurs. We shall next examine how she progresses from being a listener to the verbal productions of others to becoming a speaker-listener in her own right.

Echoic Behavior

Vocal precursors of echoic behavior. Although human infants show a wide range of vocalizations, including the universal consonant-vowel "babbling" patterns (Dale, 1976), vocal approximations to conventional verbal behavior are not generally acquired until around the end of the first year (Locke, 1980; Oller, Wieman, Doyle, & Ross, 1976). Using social reinforcement, several studies have shown operant conditioning of young infants' vocalizations (e.g., Rheingold, Gewirtz, & Ross, 1959; Weisberg, 1963), and Routh (1969) has demonstrated selective reinforcement of both consonant sounds and vowel sounds in infants ranging from 2 to 7 months old. In observational studies it has been found that infants' babbling matches the tonal qualities produced by their own verbal community (Weir, 1966), occurs at a higher pitch to mothers as opposed to fathers (Lieberman, 1967), and converges upon a subset of the sounds that in combination form words used by their particular linguistic community. Oller and Eilers (1988) have shown that infants with severe hearing difficulties, on the other hand, show very delayed onset of this consonant-vowel babbling; they also reported that the one entirely deaf child in their study never produced such utterances. Taken together, these results indicate that both the onset and form of infants' babbling are dependent upon exposure to the speech sounds of their verbal community. Raising the operant level of such vocalizations is an important step towards the acquisition of speech, given that the particular syllables produced by infants' babbling tend to be the same ones used in early naming (Vihman, 1986, p. 448).

Learning to echo. According to Skinner, the early productive repertoire of verbal behavior consists of separate classes of functional relations. The *echoic* (Skinner, 1957, p. 55; see Catania, in press) is one of the earliest and most basic of these, and involves the reproduction of the verbal productions of others. That is, infants gradually learn to move their vocal musculature in such a way as to partially or completely reproduce or "echo" a heard verbal stimulus; this occurs, for example, when caregivers say a given word and reinforce vocalizations of the infant that approximate the sound of that word. Poulson, Kymissis, Reeve, Andreatos, and Reeve (1991) have demonstrated vocal imitation in 9- to 13-month-old infants who were praised when they produced an utterance that matched (i.e., approximated) that of an adult vocal model. In addition, they found that some generalized echoic behavior occurred; after learning a set of reinforced echoic relations, the infants imitated novel vocal stimuli in the absence of response-contingent social reinforcers. Other studies have indicated that children imitate caregivers' speech a great deal, particularly in the early stages of language learning (Clark, 1977; Moerk, 1992; Ryan, 1973; Slobin, 1968), and, in addition, that caregivers imitate their children's utterances (Kaye, 1982; Moerk, 1983).

The kind of interaction that gives rise to echoic behavior is represented in Figure 7. Because, unlike Skinner's account, listener behavior is central to our analysis of echoic behavior, we have in this and subsequent illustrations attempted to show how the child's own speaker and listener behavior may interact. This enables us to show how the second link of the name relation (see Figure 4) (i.e., the relation between the child making an utterance and her hearing of it) is established. In Figure 7, we have also indicated contextual stimuli (e.g., a shoe and the child's pointing to the shoe) that occasion the caregiver's initial verbal response because such contextual stimuli, although not invariably present in all instances, are a common feature of echoic interactions between the caregiver and the young child (Harris, Jones, & Grant, 1984).

In Figure 7, the caregiver, seeing the shoe, says to the child while pointing to the shoe, "say shoe, shoe," with vocal emphasis upon the word "shoe." This generates an auditory stimulus to which the child responds by echoing "shoe" (R_V), or some approximation to it (e.g., "oo"), a correspondence that is reinforced by the caregiver saying "clever girl," smiling, and so on. This relation constitutes the echoic as described by Skinner. But, given that the child has already acquired listener behavior of the kind described in Figure 5, when the caregiver says "shoe" the resulting stimulus */shoe/* will also occasion the child's listener behavior with respect to the shoe (e.g., looking at or orienting to the shoe). In addition, the child's echoic utterance of "shoe" generates an auditory stimulus that is also functionally equivalent to the caregiver's */shoe/* and so may initiate both the listener behavior and further utterances of "shoe" (i.e., self-echoic utterance); this may in turn lead to yet further repetitions of the echoic sequence. At this point the child becomes a speaker-listener with respect to her own verbal stimulus */shoe/*.

Maintenance of echoic behavior. In her extensive study of the verbal behavior of infants and their caregivers, Nelson (1973, p. 47) has observed that a striking characteristic of child talk is the high frequency of what we have described here as echoic and self-echoic behavior; she also notes that the functional consequences of the behavior have been little analyzed. The evidence suggests that caregivers' behavior can be an important source of reinforcement that establishes and maintains a

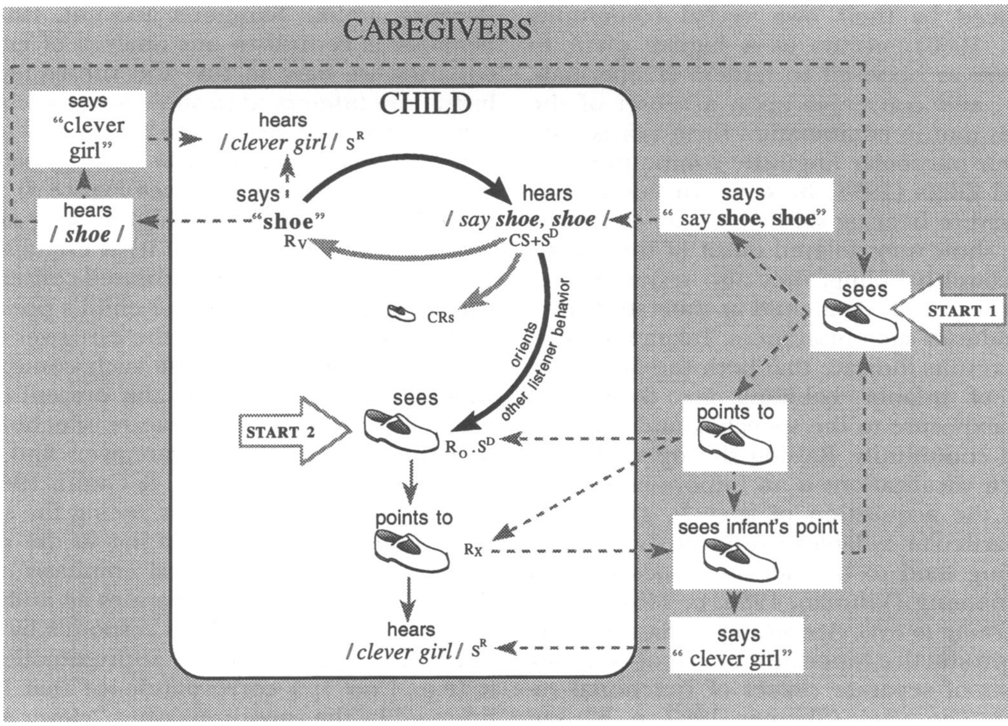

Fig. 7. A schematic account of how echoic behavior is learned by a child who has already acquired listener behavior to */shoe/*. The caregiver (START 1) points to a shoe and says to the child "say shoe, shoe." Hearing */shoe/*, the child herself says "shoe" or some approximation to it (R_V), which is reinforced (S^R) by the caregiver saying "clever girl" and so on. Thereafter, hearing caregivers say "shoe" becomes discriminative (S^D) for her echoing response "shoe." The echoic relation is thus established. But given that the child has previously learned listener behavior to */shoe/*, she now both echoes and responds as a listener to her own vocal stimulus (solid arrows) as well as to her caregiver's. The sequence may also be initiated by the child (START 2) first seeing the shoe. The black arrows constitute two of the three main elements of the name relation depicted in Figure 4.

generalized imitative repertoire, although much more research is required to demonstrate the magnitude and scope of these reinforcing effects (Kaye, 1982; Moerk, 1992; Poulson et al., 1991). Skinner (1957, p. 164) has suggested that the child may also be "automatically" reinforced when she duplicates the sounds of others. For example, the sounds and words uttered by parents may function as potent classically conditioned stimuli that have strong emotional effects on the child so that when she hears her own replication of these vocal patterns she generates stimuli that have similarly strong reinforcing consequences. Echoic behavior can also provide other consequences. Thus, for example, the child's repeated echoing of the sound */cat/* may sustain her listener behavior of looking for the cat; this may then be followed by the positive consequences of her crawling or toddling after it and stroking it (see Skinner, 1957, pp. 57–58).

Covert echoic behavior. For the echoic to be established as a functional class, the infant's echoic responses must initially occur overtly if they are to be reinforced by the verbal community. However, it is possible that what begins as an overt echoic may come to be emitted at the covert level and become increasingly abbreviated in form; this may arise particularly in the case of repetition or self-echoing (see Clark, 1977, p. 342; Skinner, 1957, pp. 76, 141–146). Such covert echoics may occasion listener behavior that, as is the case with overt echoics, will have a range of reinforcing consequences. Once the child has learned generalized echoic behavior (Poulson et al., 1991) and to emit previously learned overt echoics covertly, new echoics

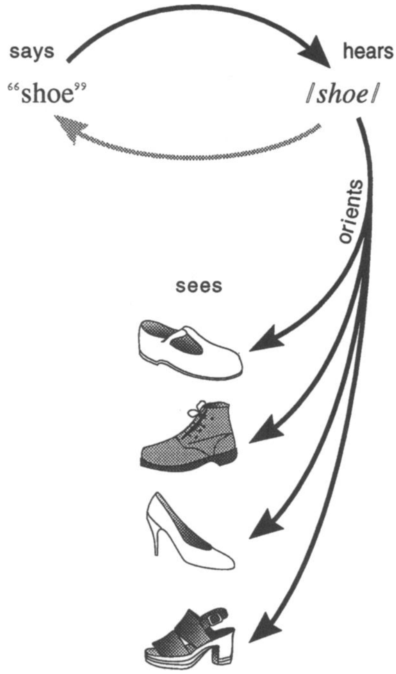

Fig. 8. When the child learns to echo a word spoken by her caregivers (e.g., "shoe"), her own auditory stimulus */shoe/* comes to occasion her looking not just at one particular shoe but at any object so named by her caregivers for which she has already acquired listener behavior.

may be acquired solely at the covert level of responding.

From listening to others to listening to oneself. Although the child can function as a speaker-listener only when her speaking is initiated by others' vocalizations, once she echoes and reechoes those stimuli this may help, even if only briefly, to sustain her listener behavior. This is perhaps the earliest approximation to self-instructional behavior.

Figure 8 shows that when the child echoes "shoe," the resulting stimulation occasions her looking not just at a single object but at exemplars of the class of stimuli for which she has already acquired listener behavior (see Figure 6). When her caregiver says "shoe," the child now also says "shoe" in the presence of shoes. Although it might appear that she is able to "name" the object present during social interactions of the kind we have described in Figure 6, her echoic response ("shoe") occurs in response, not to the shoe itself, but to another person saying "shoe." However, as we shall next describe, the echoic relation serves to set the conditions for the object itself to enter into direct control of the child's verbal behavior, thereby occasioning naming.

Naming

As indicated in Figure 7, echoic interactions often begin when caregivers talk about, and point to, objects the child is looking at, pointing to, or playing with (Harris, 1987; Tomasello, Mannle, & Kruger, 1986; Tomasello & Todd, 1983; Whitehurst & Vasta, 1975). The conditions exist, therefore, for these objects to enter into functional control of the child's verbal behavior, and this establishes new kinds of verbal relations. One of these, described by Skinner (1957, p. 83) as the most important verbal operant, is the *tact,* in which a response of a given form is evoked by a particular object or event. For example, if a caregiver presents a child with a ball and the child says "ball," the caregiver reinforces this correspondence in a variety of ways such as smiling, praising (e.g., saying "good girl"), and repeating the child's utterance (e.g., "yes! it's a ball"; see Moerk, 1977, pp. 224–235). We have attempted to illustrate in Figure 9 how, in the course of repeated echoic interactions of the sort depicted in Figure 7, the tact comes about; importantly for the present account, this also enables us to show how the final link of the name relation, the "closing of the circle," is established. In the presence of the child, the caregiver (START 1) points to the shoe and says "shoe"; the caregiver's verbal stimulus */shoe/* occasions the child's looking at the shoe and repeating to herself "shoe," with the result that the sight of the shoe becomes a frequent antecedent for the utterance "shoe"; this establishes the object (shoe) as a discriminative stimulus for the child's own future utterance of "shoe." From this point onwards, when the child sees the shoe (START 2), it alone, without need for the caregiver's speaking, occasions the verbal response "shoe" and its attendant listener behavior. It is at this stage that we can say the child has learned to name the shoe. Eventually the shoe may also be "seen" or visualized when it is not present (i.e., conditioned seeing), and this conditioned visual stimulus may also give rise to the utterance "shoe" (cf. Huttenlocher & Smiley,

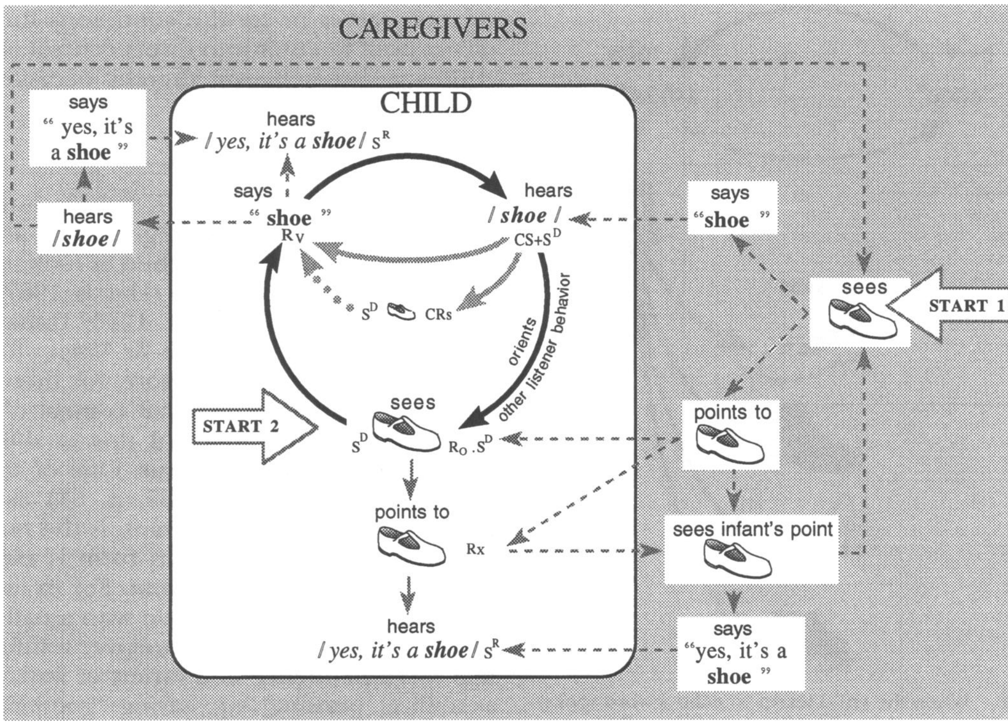

Fig. 9. A schematic account of how naming is learned by a child who has already learned both to echo and to listen to the auditory stimulus */shoe/*. The sequence begins (START 1) when the caregiver points to a shoe and says "shoe." The auditory stimulus */shoe/* now occasions the child's looking at the shoe while she echoes and reechoes "shoe." In this way the sight of the shoe becomes a frequent antecedent and then discriminative stimulus (S^D) for her saying "shoe." Thereafter, when the child (START 2) sees the shoe, it alone occasions her saying "shoe" (R_V). This provides the final link of the name relation depicted in Figure 4—naming is now established. The shoe may in addition be visualized (CRs) when it is not present (such conditioned seeing being evoked by a reliably accompanying object, e.g., a sock); the resultant stimulation (S^D) may also occasion (gray dotted line) the utterance "shoe" (see text).

1987); this relation is indicated by a gray dotted line in Figure 9.

One part of the total relation described in Figure 9—namely, the relation between the shoe as a discriminative stimulus and the verbal response "shoe" (supported by the generalized reinforcement from caregivers)—is sufficient to meet the criterion for Skinner's tact relation. Although it may be the case, as with the echoic, that tacting can occur without conventional listener behavior, we have shown in the previous sections that the most likely way for a tact-like relation to come about is via previously established echoic and listener relations. This means that when a child sees an object and makes a tact response, a verbal stimulus is thus generated that occasions her immediate seeing again or reorienting to that object. As shown in Figure 9, when the child sees an object such as a shoe, she says "shoe," hears herself say */shoe/*, and in response to that stimulus sees the shoe and otherwise engages with it again. This sequence may be repeated many times. As Figure 10 shows, however, hearing herself say */shoe/* may occasion her looking not just at a particular shoe but at any of the other shoes or pictures of shoes in that listener behavior class (see also Figures 6 and 8). Thus, naming involves the establishment of bidirectional or closed loop relations between a class of objects and events and the speaker-listener behavior they occasion.

This fusion of conventional speaker and listener functions establishes a qualitatively new bidirectional relation in the child's behavioral repertoire. From this point on, she does not simply respond to an auditory stimulus originating from others as in preverbal listener behavior, nor does she simply echo vocal

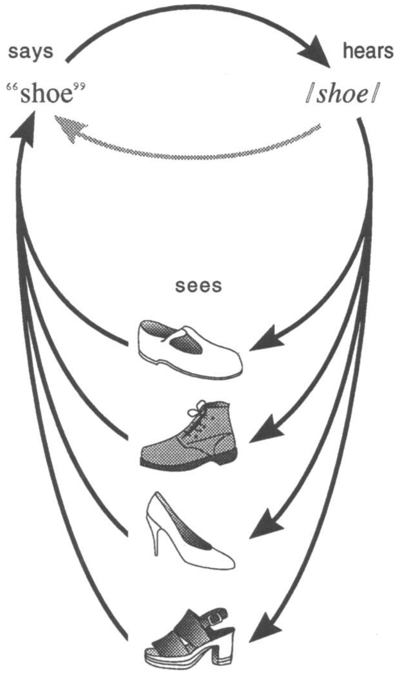

Fig. 10. When the child now sees a shoe to which she has previously oriented as a listener, this evokes the response "shoe" and, hearing her own auditory stimulus /*shoe*/, she orients to any of the shoes in her listener behavior class that are present. She may once again say "shoe" and again orient to a shoe exemplar and so on. Naming may thus be evoked initially either by seeing a shoe or by hearing /*shoe*/, and may be reevoked either by seeing a shoe again or via the self-echoic relation (gray arrow). In this manner bidirectional relations are established between a class of objects and the speaker-listener behavior they occasion.

stimuli, nor does she simply vocalize when she sees an object, as the definition of the tact relation might suggest. Naming has properties and effects on the rest of behavior that go far beyond those of tacting, echoing, or listener behavior on their own. As Skinner (1957, pp. 82, 88) acknowledges, we cannot say of a tact that it, for example, *represents* or *reminds* us of the stimulus; *refers* to it; *stands for* or *substitutes for* it; *specifies* or *means* it. In sum, the tact relation between a stimulus and a response is unidirectional and nonsymbolic. On the other hand, as we shall attempt to show, the name relation as outlined here has all of these defining characteristics of symbolic behavior (Sinha, 1988).

Indeed, there is evidence that casts doubt on whether tacts, as opposed to names, feature very much in the child's early verbal repertoire. For example, studies by Huttenlocher and Smiley (1987) and Harris et al. (1995) have shown that once infants have learned to make a verbal response of a given form in the presence of a particular object (i.e., a relation that formally resembles the tact), they almost invariably also show appropriate listener behavior (e.g., if the child can say "dog" in the presence of a dog, she will also respond appropriately if asked "where's the dog?"). This linkage at the single name stage between production and comprehension in infant behavior has been widely noted in the literature (Bowerman, 1980; Gruendel, 1977; Rescorla, 1980). The evidence indicates, therefore, that because listener behavior is so closely tied to production, studies that explicitly measure infant production repertoires are also providing an indirect measure of listener behavior and thus of naming. This is further supported by the evidence that, once the child learns to be a speaker-listener with respect to a particular object, she is also able to name others in the same stimulus class to which she has previously responded only as a listener (Harris et al., 1995). This would also be expected from our account. For example, we have shown that before she learns to name shoes the child acquires listener behavior in response to others saying "shoe," which is directed toward a variety of shoes and illustrations of shoes; the shoes themselves also come to evoke the same conventional behavior as that occasioned by the vocal stimulus. Given repeated instances of the interactions depicted in Figure 9, the conventional listener behavior directed toward shoes, because it frequently precedes the vocal response, itself becomes discriminative for occasioning the name. Thus, whenever she encounters any one of the objects in the previously established listener class, it occasions a particular pattern of conventional behavior that is common to those objects, which in turn evokes her utterance "shoe."

But this is only one means by which the name relation continues to evolve over the lifetime of the individual. For example, the child may extend a name (e.g., "shoe") beyond the original stimulus to new stimuli that either physically resemble it (e.g., boots) or have reliably accompanied it in the past (e.g., socks). Extension of the name relation (e.g., "shoe") may also occur when a novel object evokes behavior (e.g., putting her foot in a box) that closely resembles listener behavior already embodied in a name relation; the common behavior evokes the name ("shoe") in both instances, and the novel object is now so named. The name relation may therefore be extended on the basis of the common function as well as common physical features between a novel object and the original referent (Lewis, 1936, pp. 197–199).

Some extensions, as in the examples above, involve idiosyncratic generalizations that are at odds with the way the verbal community uses a particular name. Idiosyncratic extensions of this kind may be corrected by caregivers. Thus in the case of overextension (overgeneralization), the caregiver may, for example, say "no, that's not a dog, that's a cat." On the other hand, if the child says "cup" only in response to seeing a particular cup, the caregiver will point out other cup exemplars and establish the name to those also. In this way a balance is struck between the child's tendency to idiosyncratically generalize the name on the basis of structural and functional properties already encompassed by it on the one hand, and, on the other, the continuing efforts of the verbal community that keep the name relation within the bounds of the socially shared (Vygotsky, 1934/1987, pp. 255–285).

Echoic behavior as a determinant of naming. According to our account, the echoic repertoire constitutes a critical link in the development of the name relation because it determines whether a listener relation can become a speaker-listener relation. It should also be noted that in early word learning, when the echoic repertoire is very limited, infants can echo only those names (and then only partially) that have a phonetic element in common with their existing echoic repertoire (cf. Skinner, 1957, pp. 59–60). What the child can echo will thus determine what she can name. In support of this account, several studies have shown that children's early verbal productions that approximate caregivers' names are heavily dependent upon the small set of speech sounds they can already articulate either singly or in combination (Ferguson & Farwell, 1975; Ferguson, Peizer, & Weeks, 1973; Menn, 1976; Schwartz & Leonard, 1982).

Because the vocal stimuli the child can echo will determine what listener behavior can become incorporated into name relations, listener skills (or comprehension) should accordingly outpace naming skills until the echoic repertoire is well advanced. This prediction is supported by many studies that have shown that, initially, children's learning of listener behavior to words is much faster than their production of those words (Benedict, 1979), so that on average, by the time 60 listener relations have been learned the child has produced only 10 words (Benedict, 1979; Goldin-Meadow, Seligman, & Gelman, 1976; Greenfield & Smith, 1976, pp. 219–220; Snyder et al., 1981). Later, however, as the naming and the echoic repertoires increase, the discrepancy between listener and production skills diminishes (Anisfeld, 1984, p. 82).

The acquisition of an echoic repertoire may also have an important bearing upon the common phenomenon described in the literature as the *naming explosion.* This refers to the very rapid acceleration in name acquisition that occurs after approximately the first 10 to 20 names have been learned, normally when children are around 18 months old. According to the present account, it may not be possible for many new names to be acquired until a critical number of echoic relations, with differing phonetic characteristics, have been learned. As the number of these echoic relations in the repertoire increases, the combinatorial possibilities for producing more name utterances rises exponentially. A further determinant of the name explosion is considered in the next section.

Naming as a new higher order relation. In the interactions between child and caregiver described so far, we have noted that joint visual attention to objects is often established by means of cues provided by the caregiver such as pointing or phrases such as "where's the . . ." or "that is a . . .." Although early name relations may be learned piecemeal (see Figures 5, 7, and 9) with listener, echoic, and tact components established separately, with repetitions of the interactions shown in Figure 9 the cues of the caregiver's naming of and pointing at a new object come to be sufficient on their own to evoke the full sequence of behavior that makes up the name relation. Nelson and Bonvillian (1973), for example, have reported that children 18 months and older can learn new object names after an adult has named the objects in their presence only once or twice. Thus, the name relation is established as a *higher order behavioral relation* (see also Catania, in press) that short-circuits earlier means of constructing it. As with the echoic, higher order naming may become increasingly covert and abbreviated in form and may indeed be learned at the covert level of responding, this being reinforced and maintained by a range of consequences (see Skinner, 1957, pp. 141–146).

Maintenance of naming. Initially, the name relation in young children is supported by caregivers providing a range of generalized reinforcers, such as smiling, praising, and repeating what the child has said. Studies have shown that thereafter the frequency of external reinforcers from caregivers and others simply for correctly naming objects declines markedly (Moerk, 1977, p. 265). However, when the child names an object in the presence of a caregiver, she almost invariably evokes the latter's attention both to herself and to the object that she has just named and with which she is engaged; this attention is a rich source of reinforcement for the child's naming, as is the joint activity with the named object that often ensues (Prorok, 1980).

Important sources of reinforcement, however, are increasingly embodied within the name relation itself. For example, the reinforcement provided by the conditioned stimuli, operant or Pavlovian, that naming produces and by the listener behavior that naming occasions (together with its consequences) may be sufficient to maintain naming behavior at strength (see Skinner, 1957, pp. 86, 163–166, 438–452). Thus a child who emits the name "mama" in her mother's absence may "see" her, "hear" her, "smell" her special scent, and "feel" her comforting touch. Naming that, via conditioning, generates such effects is reinforced because it does so. The verbal stimulus may also serve as a discriminative stimulus for a range of listener behavior with a variety of consequences. For example, the child's saying the word "mama" may set the occasion for her to visually or otherwise search the environment until she finds her mother—a potent reinforcer for that naming behavior. Once "mama" is found and held in attention, other behavior can be initiated (e.g., her mother may provide a drink, a cuddle, or play) that may also serve as a rich source of reinforcement that will maintain the naming behavior that preceded it (Huttenlocher & Smiley, 1987). These and other effects of naming (see below) serve to maintain it at high strength and begin to free it to some extent from the direct reinforcing practices of the verbal community. This does not mean, of course, that the verbal community then ceases to play a decisive role. On the contrary, caregivers and others continue to exert a powerful influence on its further development, maintenance, and generalization (Harris, 1992; Moerk, 1983).

The development of naming. From the time she first names an object or event, the child's name relations continue to change and develop throughout her life. For any particular name, additional stimulus events come to occasion her verbal utterance, and there are concomitant changes in the listener behavior that the utterance evokes. This is the means by which socially shared listener behavior as well as idiosyncratic listener behavior are established (see Mead, 1934, pp. 135–226; Vygotsky, 1934/1987, pp. 255–285). We have tried to capture this process in Figure 11, which shows what happens when a child, who has previously learned to say "dog" only in the presence of toy dogs and pictures in books and to point to them upon hearing "where's the dog?" encounters a real dog for the first time. When the child first sees the dog (A), the visual resemblance between the previously seen objects and the real dog is sufficient to evoke, via stimulus generalization, the child's verbal response "dog" and her pointing to the dog. She now sees a dog that moves, and she hears the sounds of panting and whining that are characteristic of real dogs. These new properties, as well as the previously learned visual features, come to be discriminative for her saying "dog" in future encounters with dogs. Her saying "dog" generates the auditory stimulus */dog/* that in turn evokes conditioned visualization of previously encountered pictures and toy dogs but also now occasions visual reorientation to the real dog that is present. As she repeats the name "dog," further pairings of */dog/* with seeing and hearing a real-life dog may result in the verbal stimulus evoking thereafter not just conditioned seeing but also conditioned hearing of a dog (shown in B), each of which,

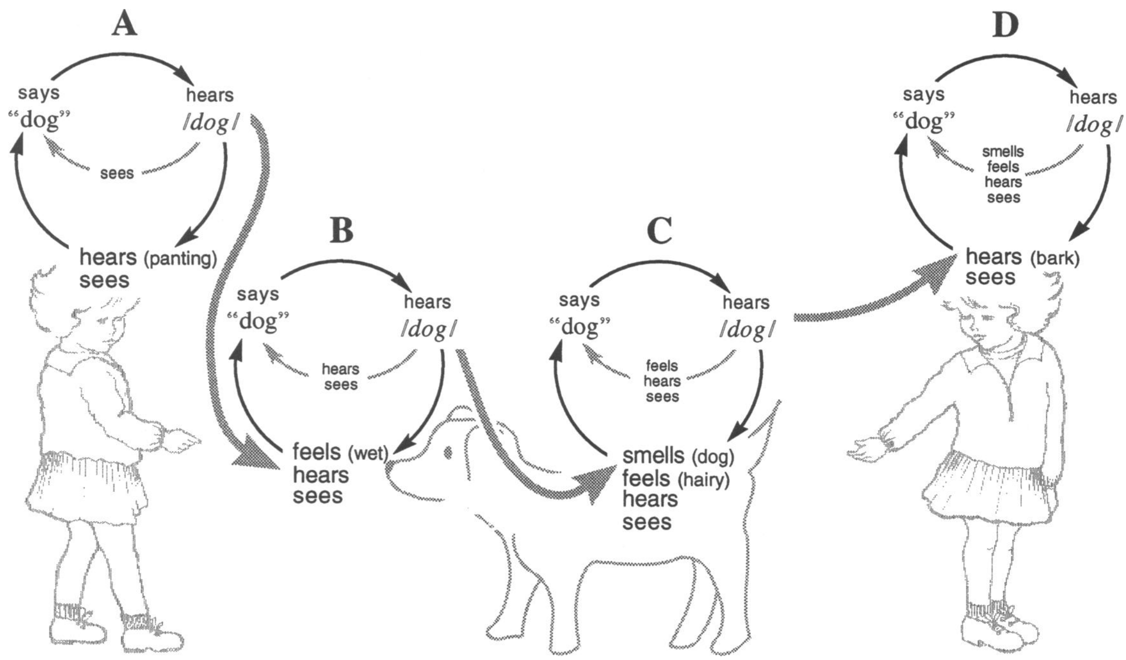

Fig. 11. Ongoing multimodal development of the name relation: The child in this example has previously learned to say "dog" when seeing pictures of dogs and toy dogs. She next learns to say "dog" also when she sees a real dog; sees it move and hears it pant (A), touches its wet nose (B), pats its back, smells and feels its coat (C), and hears it bark (D). The name relation may now be evoked by any one, or some combination of, these new stimuli. In addition (as indicated by the inner gray arrows of name relations A, B, C and D), the auditory stimulus */dog/* comes to occasion conditioned seeing, feeling, smelling, and hearing of dogs, which may, in turn, evoke saying "dog" and so on.

even in the absence of a real dog, may later set the occasion for further emissions of the name. Similarly, when the child touches the dog's wet nose (B), pats its back, smells and feels its coat (C), and then hears it bark (D), each of these new events join the previously encountered stimuli as potential discriminative stimuli for the emission of the verbal response "dog" in the future. In addition, the auditory stimulus */dog/* will henceforth give rise to new listener behavior including, for example, touching, patting, and stroking, as well as conditioned seeing, feeling, smelling, and hearing of dogs and properties of dogs.

Figure 12 shows in detail how the child's name relation, "dog," alters in the course of her interactions with the real dog. This name relation will continue to develop in the course of further encounters with other breeds of dogs, other features of individual dogs, and other illustrations of dogs. And on each new occasion the name "dog" is uttered, it will carry with it the generalized listener behavior, including affective responding, accumulated from previous encounters with dogs, listener behavior that itself is changed by each further encounter with dogs or any of their attributes and the consequences of these interactions. Thus, the stimulus */dog/* comes to evoke a myriad of sights, sounds, tactile sensations, and smells of dogs and conditioned affective responding.

Naming and functional stimulus classes. The verbal community instructs the child not only which objects with similar appearance have the same name but also assigns common class names to objects that, although they may have little in common physically, serve a shared cultural function, that is, are functionally equivalent (Mead, 1934, pp. 83–85; Brown, 1958, p. 85). The name "chair," for instance, is used in this culture for a range of objects that are of varied shape, color, and size and made of differing materials. Having learned to use "chair" in the single case of her bouncing chair, the child may not extend the name to other chairs until the conventional class is established by caregivers who

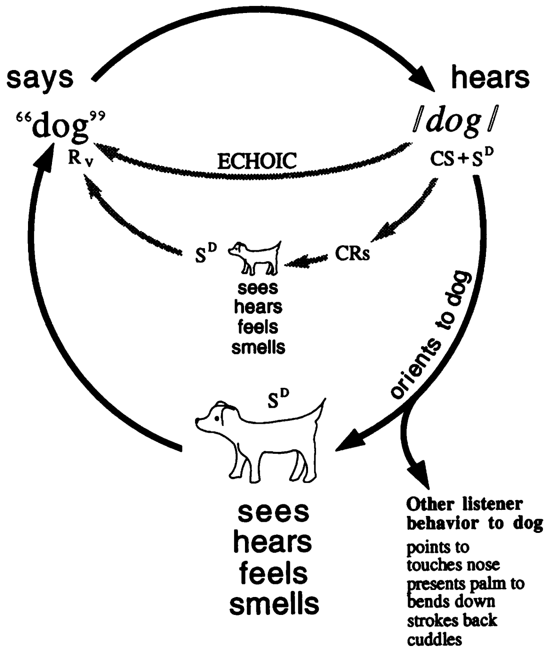

Fig. 12. Schematic representation of changes in the name relation across modalities resulting from the interactions depicted in Figure 11. When the child now sees, hears, feels, or smells a dog, she may say "dog." When in turn she hears her auditory stimulus */dog/* she may orient to a dog, and point to it, touch its nose, pat it, and so on. In addition, the auditory stimulus */dog/* may evoke (lower gray arrow) conditioned seeing, hearing, feeling, and smelling of dogs (CRs). The echoic relation between her own auditory stimulus */dog/* and her saying "dog" (upper gray arrow) may reevoke this conditioned responding and occasion further revolutions of the name relation as a whole.

point to other "chairs," naming them as such. The child's acquisition of the name of a conventional stimulus class such as "chair" confers major functional benefits. For example, having been taught to sit on what caregivers call a "chair," the child adopts the cultural function of chairs in general when she adopts the name and extends it, together with associated listener behavior, to new exemplars. So when told that a new and unusual object is a "chair," the child will immediately be able to respond (i.e., by sitting on it) in a way that is both conventionally acceptable and intrinsically reinforcing. These culturally defined functions thus become for her an integral part of her listener behavior to the name "chair." Indeed, when she sees someone sitting on an object or finds that she can sit comfortably on it, she may declare that it is a "chair." It should be noted that this extension of the name has not been directly trained or reinforced but occurs "spontaneously" via common listener behavior (i.e., sitting) that gives rise to the verbal response "chair." In this way there is a blending of cultural and personal factors to further extend the stimulus class that bears the common name.

At a later stage, the child may, for example, be taught the name "furniture" for her various items of doll furniture for which she already has other names (e.g., "chairs," "tables," "beds," etc.). Although at one level of classification chairs are objects that people or dolls sit on, at another more general level chairs are furniture items to be arranged and rearranged with other such items and moved from room to room or from house to house and so on. When the child calls chairs "furniture," she moves to a more general level of functional equivalence. In this way, naming, incorporating as it does bidirectional relations between a single verbal response and a class of objects or events, can establish and maintain more than one level of functional equivalence.

Naming and emergent behavior. The fact that names relate to classes of objects has profound implications for the development of new or untrained behavior. Figure 13 (left) shows, for example, a child who has learned to use the name "furniture" for a range of items of doll furniture and who, in addition, has been shown how to put some of these items (e.g., chairs and chests of drawers), but not others, into a toy van. If now, as shown in Figure 13 (right), the caregiver instructs her to "put the furniture into the van," she may scan the toys repeating to herself "furniture" and extend to all the furniture items the same listener behavior that has been established previously just for the chairs and chests of drawers; that is, she will put all the furniture and not just the latter items into the van. There is thus no need for the caregiver to reinforce the target behavior with each individual object; it is sufficient to establish it with some of the exemplars and then use the name "furniture" to effect generalization to the remaining items in the furniture class. We have here, in other words, new responding directed at all of these additional items; the child treats each in a similar way, that is, as if

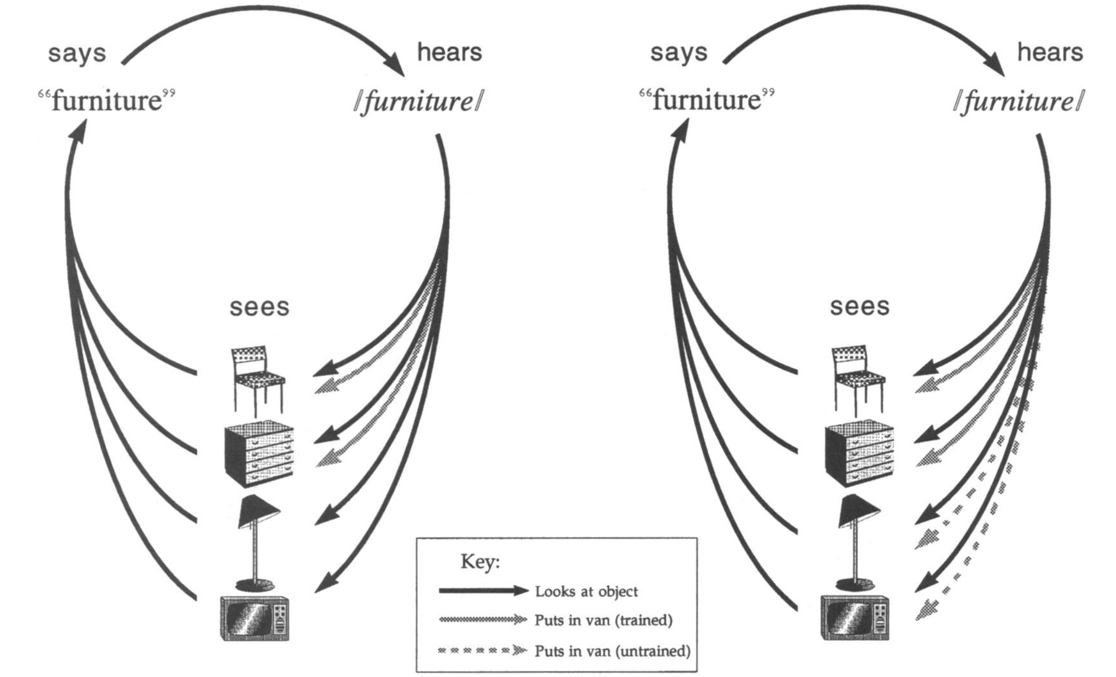

Fig. 13. Schematic representation of how naming brings about new behavior. A child is taught to name individual items of dolls' furniture (e.g., a chair, chest of drawers, lamp, television) as "furniture." Independently of this she is trained to load some of them (e.g., chair and chest of drawers) into a toy van (left). Subsequently, when instructed to "put the furniture in the van," she may show the untrained behavior of putting the lamp and television into the van (right).

each were functionally equivalent. Other conventional behavior pertaining to the class "furniture" may be rapidly learned in the same manner. This brings us to the question of how naming can give rise to emergent or derived relations, such as those observed in studies of stimulus equivalence.

If taught a common name for members of a class of physically different stimuli, a child may, when presented with a single exemplar of the class, select other class members without having ever previously been directly trained to do so (see Eikeseth & Smith, 1992). For example, a child may be taught to name as "two" pairs of objects (e.g., two dots, two apples, etc.) and, independently, to name and select as "two" the numeral 2. When, as part of a matching game, she is subsequently shown a pair of objects on one page of a book and asked to "pick the one that goes with them," she may be able, without further training, to select the numeral 2 from an adjacent page illustrating different numerals. According to our account, as shown in Figure 14, this comes about because the pair of objects occasions her saying "two" which in turn evokes the previously established listener behavior of selecting the numeral 2. In a similar manner, when later shown the numeral 2 on the sample page, she may be able to select the pair configuration from among groups of differing numbers of objects on the comparison page. Later she may learn that the printed word TWO is also named "two" and when then presented with TWO may match it variously to the numeral 2 or to two objects, in appropriate choice contexts.

Thus, as shown in Figure 14, by teaching the child to use the common name "two" for each of the three stimuli, up to six new behavioral relations may emerge, apparently spontaneously, but in fact through the listener behavior engendered by the name. Evidence that new behavioral relations can be established in this manner comes from a study by Eikeseth and Smith (1992) with autistic children (see pp. 224–225), although further research is needed to provide a sys-

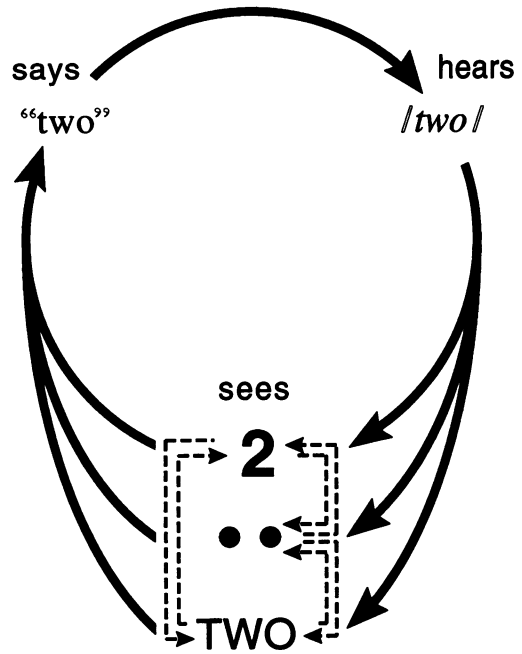

Fig. 14. When a child is taught to name as "two" the numeral 2, two dots, and the printed word TWO (solid arrows), up to six new behavioral relations (broken arrows) may result. Whichever of these stimuli is presented to her she will say "two" and hear */two/*; this will evoke her orienting towards and selecting from the available comparison stimuli any one or more of those stimuli that she has previously named "two."

tematic investigation of this kind of emergent behavior. There are many other possible examples of such stimulus classes, the child learning in a similar way the interchangeability in some contexts of particular object classes (e.g., dog), particular spoken words (e.g., "dog"), and particular arrangements of printed letters (e.g., DOG). Any of these stimuli may occasion the same name so that the same listener behavior (e.g., selecting) may be directed towards other members of the same stimulus class. Such behavior has been termed *stimulus equivalence,* and we have shown how one very basic form of naming—that is, common naming—can bring it about. We shall address others below.

Towards a definition of naming. According to our account, naming is a higher order bidirectional behavioral relation that combines conventional speaker and listener functions so that the presence of either one presupposes the other. Thus, when higher order naming skills have been established, even if caregivers ostensibly teach the child only conventional listener behavior (e.g., orienting to and picking up a shoe in response to the utterance "where's shoe?"), she will nevertheless also exhibit the corresponding speaker behavior (saying "shoe" in response to seeing the shoe). Likewise, when only speaker behavior is ostensibly taught (e.g., when the caregiver points to a dog and says "dog," the child repeats the utterance and learns to say "dog" herself when she sees it), the child also acquires listener behavior (so that when next asked "where's dog?" she orients and points to it). Second, we have shown that once the higher order name relation has been learned by the child, there may be no need for the verbal community to provide reinforcement to establish appropriate speaker and listener behavior; it may be sufficient, for example, for caregivers merely to point to and utter the name of a novel object for the full name relation, incorporating both speaker and listener behavior, to be established. A third crucial feature of a name is that it is used by the verbal community, and hence the child, not for a particular stimulus but for conventional classes of objects and events. A child learns to say "shoe" when she sees one of many kinds of shoe, from any of a multitude of perspectives, in any of a multitude of contexts. As a consequence, new listener behavior trained with just one or two members of the named class may come to be occasioned by any one or all of the others, and training a common name for a number of different objects results in the child's treating them interchangeably in some contexts.

To summarize, we can now define naming as a higher order bidirectional behavioral relation that (a) combines conventional speaker and listener behavior within the individual, (b) does not require reinforcement of both speaker and listener behavior for each new name to be established, and (c) relates to classes of objects and events. This definition has clear implications for attempts to determine experimentally whether or not subjects can name. One possible test would involve the training of speaker behavior in relation to a novel stimulus and then testing for the presence of conventional listener behavior. This could, for example, be achieved as follows. First it would be necessary to ensure that conventional listener behavior had been established with other stimuli (e.g., looking or pointing at the correct object when the caregiver says "where's X?"). The caregiver would then point to a novel object (e.g., a toy giraffe), say "giraffe," and reinforce the subject's saying "giraffe" when the latter was presented; other vocal responses could be established with other novel objects in a similar fashion. The test for naming would consist of presenting all the objects together and asking the subject, "where's the giraffe?" If the subject had learned the name, as distinct from mere speaker behavior or tacting, she should proceed to show the conventional listener behavior of looking, or pointing, at the toy giraffe.

A more demanding test would be to follow a similar procedure to that outlined above but, when the caregiver named the objects in the presence of the subject, provide no reinforcement. Given that the higher order name relation had already been learned by the subject with other objects and events, this procedure might nevertheless be sufficient to establish both conventional speaker and listener behavior for novel objects and events.

A yet more stringent test would be one that capitalized upon the fact that naming is concerned with stimulus classes. Having taught either conventional speaker or listener behavior in the presence of a given stimulus (e.g., a shoe) in the manner outlined above, either with or without reinforcement, it should be possible, if naming has been established, to extend it to other physically different exemplars of shoe by the caregiver simply pointing to each of them and saying "shoe," with the subject's correct speaker behavior being reinforced throughout. The same could be done for other object classes (clothes, furniture, toys). If the subject has learned the name "shoe," then, in the presence of exemplars of shoes among other objects, when the caregiver presents one of the shoes saying "see this, where are the others?" the child should be able, via her own overt or covert utterance of the name, to select others in the class. This final part of the test, involving as it would the presentation of a sample and the requirement that the subject choose the appropriate comparison stimuli, bears a close resemblance to match-to-sample tests for stimulus equivalence. The principal difference lies in the training given. Unlike match to sample, in the naming procedure stimuli from the same class are not presented together but are presented as individual exemplars named individually by the experimenter. In the procedure we have outlined here, the subject's speaker behavior would be reinforced during training, but even this might not be necessary.

These naming tests, like tests of stimulus equivalence, all involve what might be termed *emergent* or *derived* relations. That is, we direct reinforcement or training at speaker relations alone but obtain new or additional listener relations. In the case of the stimulus class tests, we confine training to a set of object-word relations but get many new kinds of object-object listener behavior. In both cases, insofar as the new behavior has not been explicitly reinforced during the testing procedures, it might be said that it is emergent or derived. These terms are most often used, however, to describe behavior for which the controlling variables are unknown (see Mead, 1934, p. 198); hence, they frequently occur in the literature on stimulus equivalence. Our account of the emergent phenomena in the above cases, on the other hand, shows that they all involve learned behavior and relations that are established through naming. Although naming is responsible for bringing into the repertoire a great many new behavioral relations, it is itself learned behavior, and its operations can be understood through behavior analysis. To the extent that we can give an account of naming and its effects on other behavior, the concepts of emergent and derived may in this context become redundant.

Naming through other modalities. The present account, although based upon behavioral interactions between caregivers and children who are not sensory impaired, should also be applicable to those who do have sensory impairments (e.g., those who are deaf or blind). In order to learn the name relation, such children require a sensory modality through which they may learn (a) to discriminate arbitrary but conventional stimuli provided by their verbal community (which might, in the case of deaf children be manual signing, or in the case of blind children, speech), (b) some of the conventional functions of objects and to perform these forms of behavior in response to the corresponding conventional stimuli (i.e., listener behavior), and (c) to reproduce (echo) those stimuli themselves (e.g., by signing or speaking) while responding to the corresponding objects. In this way these children can learn to emit arbitrary but conventional behavior that evokes their own conventional listener behavior as well as that of others in their verbal community who share the same conventions. Under such conditions, naming should be effectively established. Indeed the evidence shows that young children who are deaf or blind learn to sign or speak, respectively, and thus to name, at rates similar to those of children without sensory impairment (Folven & Bonvillian, 1991; Mulford, 1988; Pettito, 1992).

Intraverbal Naming

The effectiveness of naming in bringing about new or emergent behavior is greatly enhanced as soon as the child begins to use names not just singly but in combination. Once children at around the age of 18 months have acquired a repertoire of, on average, 50 approximations to single conventional verbal responses they begin to combine these, initially to form response pairs (Anisfeld, 1984). For example, the caregiver may often repeat the words "big teddy" to the child and the child may echo these words; in this way, the verbal stimulus */big/* comes to reliably occasion the child saying "teddy." When the caregiver says "big . . .?" the child says "teddy" and is praised by the caregiver for doing so (Goodwin, 1985; Greenfield, Reilly, Leaper, & Baker, 1985; Harris, 1987). This form of verbal behavior has been termed the *intraverbal* by Skinner (1957, p. 71) and it is characterized by a relation in which, like the echoic, a verbal stimulus is the occasion on which a particular verbal response receives generalized reinforcement. However, we propose that, as in the case of the echoic and the tact, the intraverbal can exist in two forms, one with and one without conventional listener behavior. There is indeed evidence (a) that children do learn from their caregivers sequences of vocal utterances or "words" (e.g., simple repetitions of adult speech such as nursery rhymes) that are initially devoid of conventional listener behavior, and (b) that this may be important for the subsequent development of intraverbal naming (Clark, 1977; Moerk, 1977, p. 244; Skinner, 1957, p. 56; Slobin, 1968; Whitehurst & Vasta, 1975). However, in what follows we shall focus upon intraverbal relations between names.

Bidirectional relations between names. With self-echoic repetition, which is a common feature of children's verbal play (Moerk, 1992), the relation between the individual name components in an intraverbal is easily reversed (Clark, 1977). Thus, the child's repetition of the intraverbal "knife fork" yields "knife fork knife fork knife fork" and, because "fork" frequently precedes "knife," the child may come to say "fork knife." Clark and van Buren (1973, p. 85), for example, report that a 2-year-old child learned in this fashion to make the following utterances: "towel wet towel," "noisy man noisy," "back pin back," and "soap want it soap." The intraverbal relation is therefore not a rigid unidirectional sequence of behavioral components but may be bidirectional. If additional terms are added to the sequence, then many new combinations may emerge. For example, if the child comes to self-echo "fork spoon" in addition to "fork knife," then when she next responds to the stimulus */fork/*, it may be to say either "spoon" or "knife," because both have in the past regularly followed this stimulus (cf. Skinner, 1957, pp. 71–76). With still further echoic repetitions, the end result may be sequences such as "fork knife spoon" or "fork spoon knife" and so on. Thus many possible combinations of the constituent terms of an intraverbal may be produced by the child and, depending in part upon their proximity to conventional usage, some of these may be reinforced by the verbal community.

How intraverbals can reflect conjunctions of objects and events. The child learns intraverbal behavior not only through echoing the verbal behavior of caregivers and others but also through naming successively two or more items, or properties of items, or events that tend to coexist in her environment (Skinner, 1957, p. 75). A child who has learned to name a fork and a spoon individually may also come to say "spoon fork" or "fork spoon" when she regularly sees the spoon and fork together at meal times. With self-echoic repetition the two names may become bidirectionally related so that when either is emitted it occasions the other. For example, upon seeing a spoon the child may say "spoon fork" and, in the absence of the fork, search for it (Skinner, 1957, pp. 75–76). This type of intraverbal relation has particular relevance for studies of stimulus equivalence (see pp. 218–221, *Intraverbal Naming and Stimulus Equivalence*).

Interchange of listener behavior across intraverbal names. Irrespective of how intraverbals are acquired, their emergence heralds important new developments in name relations. As we have already shown, a name becomes increasingly generalized in terms of the stimuli that occasion it and the listener behavior it sets in train, and included among these stimuli that occasion it may now be the verbal stimulation arising from another name with which it has been intraverbally related. The complexity of the relation between words within intraverbal sequences has been recognized by Skinner as follows: "Many different [verbal] responses are brought under the control of a given stimulus word, and many different stimulus words are placed in control of a single [verbal] response" (1957, p. 74). What is not acknowledged in this passage, however, is that when names are reliably linked within an intraverbal sequence, listener behavior of any one of the name relations will be increasingly evoked by the other name relations and vice versa. Thereafter, each name that has been intraverbally linked, when it occurs alone may now contain some of the listener behavior of the others. This effect is illustrated in the example of a child who, after having touched hot objects (e.g., a radiator and a cup of tea), is taught to say "hot" by her caregiver. When the child sees these objects, she says "hot," which in turn occasions avoidance behavior and elicits other emotional reactions. If the child has previously learned the name "kettle," the caregiver saying "hot kettle" can extend the child's listener behavior to the word *hot* to this other potentially hazardous item. The child, when she next sees a kettle, repeats "hot kettle," and the listener behavior already established to "hot" (avoidance and conditioned emotional responses) occurs at the same time as she says the word "kettle," which in turn comes to evoke similar listener behavior. From this point on when the child sees a kettle, either with a caregiver present or on her own, it may occasion not only "kettle" but also, intraverbally, "hot" and its attendant listener behavior. Similarly, if the child already has learned the names "fire," "cooker," and "poker," the caregiver can go on to teach her "hot fire," "hot cooker," and "hot poker," all of which extend the listener behavior to the name "hot" and also to the names "fire," "cooker," and "poker." There is thus no need for the child to learn from experience how all of these objects can harm her, because the listener behavior established to just one of them occasions avoidance of all the rest. This intraverbal means of transferring listener behavior and establishing functional equivalence between physically different stimuli has considerable reinforcing consequences both for the child herself and for the caregiver.

In the above example, the word *kettle* in its intraverbal context (i.e., "hot kettle") evokes listener behavior (e.g., avoidance and conditioned emotional responses) additional to that occurring when it is used on its own. On the other hand, "hot kettle" also eliminates some of the listener behavior that "kettle" alone might evoke (e.g., touching and playing with it). Because individual names become increasingly generalized and extended to cover ever greater numbers of objects, the verbal community combines names in this manner to specify listener behavior more precisely (see Vygotsky, 1934/1987, p. 276).

Naming and Manding

Thus far the present account has not explicitly dealt with *manding,* a class of verbal behavior that features prominently in Skinner's account. Skinner (1957) describes the mand relation as "a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation" (pp. 35–36). For example, a hungry infant may learn to say "milk" when this vocal behavior is reinforced by her caregiver giving her milk. However, just as was the case for echoic behavior, tacting, and intraverbals, we propose that manding may exist either with or without the speaker's own listener behavior to the vocal stimulus produced.

Within Skinner's broad definition of verbal behavior, it is true that some of the child's earliest verbal behavior might be classified as mands. For example, the child, when she is hungry, points to a specific object such as milk, or she cries and makes other noises until the caregiver responds by giving her milk (Skinner, 1957, p. 465). However, numerous studies have shown that in the course of learning to produce speech that approximates that of the verbal community, children generally learn to name objects and events before they learn to mand them (e.g., Anisfeld, 1984, p. 92; Halliday, 1975; Lewis, 1936, pp. 158–159; Nelson, 1973; Terrace, 1985; see also pp. 201–202). When manding comes about it does so generally via naming, that is, names are first established and then are functionally extended to mand objects and events. For example, while reaching toward her bottle of milk the thirsty child may utter the name "milk," and this may be reinforced by caregivers giving her some milk and not, as previously, simply saying "yes it is milk" or "good girl" and so on (Skinner, 1957, p. 189). In this way naming rapidly becomes multifunctional so that the child is now able to mand any object or event that she can name. Thus most mand relations (i.e., what we shall term *name-manding*) observed in human verbal behavior incorporate naming, with all of the speaker-listener functions and bidirectionality thereby entailed (Huttenlocher & Smiley, 1987). As Skinner (1957) has observed, "It is possible that all mands which are reinforced by the production of objects or other states of affairs may be interpreted as manding the behavior of the listener and tacting [we would say *naming*] the object or state of affairs to be produced" (p. 189).

Some experimental work (Lamarre & Holland, 1985; Lee, 1981) has suggested that manding and tacting are functionally independent. However, these were studies conducted with children considerably older than those who are the focus of this paper, and they employed complex propositions as verbal stimuli (e.g., "where do you want me to put the object?") and as responses (e.g., "on the left"). Whatever the relation between what these authors call *manding* and *tacting* under such conditions, for present purposes it is important to recognize that once naming of an object is established, then, after direct training on only a few mand relations, name-manding often follows. Thus Lamarre and Holland (1985) acknowledge that "in natural settings it often seems that when a speaker acquires a tact the corresponding mand appears collaterally" (p. 16). Skinner (1957, p. 188) gives the example of a child in a toy store who is unable to identify a toy and is told that it is "a doodler" (in our terms the toy has been named doodler). The child immediately says, "buy me a doodler." Evidence that names are incorporated in name-manding in this manner comes from observational studies with young children (Huttenlocher & Smiley, 1987; Moerk, 1992, p. 167) and experimental studies with a 4-year-old boy who had language difficulties (Salzinger, Feldman, Cowan, & Salzinger, 1965) and deaf students who used signing (Hall & Sundberg, 1987).

Speech for Others and Speech for Self

There are two main contexts in which naming occurs. In one the child has as listener both herself and one or more others; speech in this context is termed *social speech* or *speech for others*. The second context exists when the only audience entering into the control of the behavior is the speaker herself as her own listener; this is termed *inner speech* or *speech for self* (Diaz, 1992; Goodman, 1981; Goudena, 1992; Skinner, 1957, pp. 438–452; Sokolov, 1972; Vygotsky, 1934/1987, p. 257; Wertsch, 1979a, 1979b; Zivin, 1979). We consider speech for self here because of its importance in our later account of such issues as rule-governed behavior, thinking, and equivalence, particularly because many of the verbal determinants of these phenomena may occur at the covert level out of the easy access of experimenters and, perhaps, even of subjects themselves.

Although it has often been asserted that differences in the forms of speech that occur in these two contexts do not arise until later in childhood (i.e., around 3 to 7 years of age), Furrow (1984a) has shown they are present in the verbal behavior of children as young as 2 years old. In his study, Furrow defined speech for others as any utterance that was accompanied by the child making eye contact with the caregiver, or that occurred in the preceding or following 2 s of making eye contact. Speech for self was defined as utterances that did not meet the eye-contact criterion and were not accompanied by other social interactions with the caregiver. Among several differences observed, it was found that the child's name-manding of the behavior of caregivers occurred more frequently in speech for others, whereas in speech for self there was a higher incidence of *self-manding* (that is name-manding of her own behavior; see Skinner, 1957, p. 440) and otherwise naming her own activities. In a second study (Furrow, 1984b) found that speech for self was quieter and of lower and less variable pitch than was speech for others.

Why these differences exist between speech for self and speech for others is an issue that has not yet been fully resolved, but our account indicates that the consequences of the two types of verbal behavior differ from the outset and, as name learning proceeds, are responsible for progressively differentiating the two. When the child first names objects or events, both she and her caregiver listen to her utterance and respond to it in particular ways. But when, in the absence of any stimulation from the caregiver, the child names objects and events it sets in train a very different kind of verbal relationship in which the sole listener of her verbal productions is herself. And she is a very special listener. Whereas in social speech the child must speak in a form that is effective for the other listener, in speech for self, there is no need, for example, to speak loudly, to pronounce words fully, or even to emit as many words (see Vygotsky, 1934/1987, pp. 266–280). Thus, for example, in the presence of her mother and father, the child may make eye contact with her father and say "daddy push car," which is followed by her father pushing the car. But when the child is alone or when caregivers are not interacting with her, she may look at the same car and say quietly "push . . . push." Because she is already looking at the car, "push" alone is sufficient to occasion her own behavior of pushing the car. As Skinner has observed, speech for self, whether overt or covert, shows "very little intraverbal chaining . . . [in our example, "push"] . . . because it is intimately connected with concurrent nonverbal behavior [e.g., looking at the car]. The chaining is from verbal to nonverbal and back again . . . [and is] . . . closer to productive verbal thinking for this reason" (1957, p. 445).

As this quote indicates, Skinner was aware of many of the unique features of speech for self. He also recognized its central importance in the development of what he described as verbal thinking. For example, in describing the special characteristics of the speaker who is his or her own listener, he writes,

> He speaks the same language or languages and has had the same verbal and nonverbal experience as his listener. He is subject to the same deprivations and aversive stimulations, and these vary from day to day or from moment to moment in the same way. As listener he is ready for his own behavior as speaker at just the right time and is optimally prepared to "understand" what he has said. Very little time is lost in transmission and the behavior may acquire subtle dimensions. It is not surprising, then, that verbal self-stimulation has been regarded as possessing special properties and has even been identified with thinking. (1957, pp. 438–439)

The transfer of listener behavior between names that we have already described for intraverbal behavior is greatly enhanced and further developed in speech for self. With increases in her naming repertoire, the child can now emit a stream of names, overtly or covertly, independently of any further stimulation outside the skin other than the object or event that occasioned the first name. To this extent the child's behavior becomes less a function of current environmental stimuli and more a function of the chain or stream of verbal generalizations that is her speech for self. With the development, in addition to naming, of other types of words and of complex forms of word ordering (syntax), the child's speech is further transformed, but that is another story and one that lies outside the confines of the present paper.

The Origins of Rule-Governed Behavior and Verbal Control

The present account has implications for the distinction drawn by Skinner (1969, p. 147) between contingency-shaped and rule-governed behavior (Catania, in press; Cerutti, 1989; Hineline & Wanchisen, 1989; Zettle & Hayes, 1982). Although contingency-shaped behavior is embraced by the three-term contingency (i.e., discriminative stimulus, response and reinforcer), Skinner's definition of rule-governed behavior as that which is under the control of "prior contingency-specifying stimuli" is more problematic. As a number of authors have observed (Hayes &

Hayes, 1992; Sidman, 1990, 1992; Stemmer, 1992, p. 76), Skinner did not make clear what he meant by "specifying" and how stimuli come to have such a function. The present account helps to clarify this problem because naming is, of course, the principal means by which behavior and its consequences are specified. Names are the basic components of verbal rules and, hence, it is only through an analysis of the name relation that the effects of rules on behavior can be understood. As we show in the next part of the paper, the absence of such an analysis is a serious flaw in theories that use the construct of equivalence in an attempt to put right the deficiencies in Skinner's account.

We shall not attempt a detailed analysis of complex rule-governed behavior as it occurs in adults, but will indicate how the earliest forms of such a relation come about in young children. Take, for example, a child who from birth has had among her toys a plastic bowl. Initially she responds to this stimulus in ways much like any other nonverbal organism would; her seeing it may, for example, set the occasion for her chewing it, handling it, hitting it on the ground, and so on. Having been previously taught the name "boat" and shown how toy boats function (e.g., how they float, sink, and can be pushed along with toy passengers etc.), if she is now told that the plastic bowl is a boat, her behavior toward the bowl may be transformed as she applies to it many if not all of the kinds of listener behavior she has acquired before with toy boats. Her new behavior of floating the bowl in water, pushing it along, and so on may never have been reinforced in the past but is controlled by the name relation (i.e., the verbal stimulus) that the bowl now evokes. (If her caregiver named the bowl a "hat," then her behavior toward it would be very different.) Behavior that, like this, is under the control of name relations may be termed *verbally controlled behavior* (cf. Mead, 1934, p. 108).

With the development of naming, particularly in intraverbal behavior and speech for self, verbal control becomes increasingly more complex and pervasive. When the child says, for example, "push boat" or, while looking at the boat, just "push," such naming enters into the control of her own behavior (see pp. 211–212, *Speech for Others* . . .). What is of central importance, however, in drawing a distinction with contingency-shaped behavior is not that names specify contingencies (they may or may not do so), but that they specify the subject's own listener behavior toward particular objects and events. This is the critical feature of verbal control, which suggests that the counter term to *contingency shaped* should not be *rule governed* but *verbally controlled.*

Naming and Symbolic Behavior

We shall next very briefly outline how an analysis of naming such as this provides an approach to dealing with some of the complex issues in human language research. The aim is to extend our terminology in ways that will do justice to the complexity of the phenomena and can be shared by others in the scientific community, while at the same time maintaining the conceptual rigor of behavior analysis.

Verbal understanding. As we have shown, the child begins as a listener to the utterances of others, but the critical development occurs with the advent of naming when she produces her own utterances and responds to them as she has done to those of her caregivers, that is, in a socially shared manner (cf. Mead, 1934, pp. 89–90, 190–191; Vygotsky, 1934/1987, p. 163). In this sense the child now *understands* her own words. In addition, however, it is increasingly the case that this listener behavior, or understanding, evokes further speaking. Through continuing social interactions, her verbal understanding progressively converges upon the way the verbal community conventionally categorizes and otherwise responds to everyday objects and events (see Skinner, 1957, p. 278).

Verbal communication. Because, for each of the child's name relations, the class of stimulus events and the listener behavior to which it applies have been largely established by the caregiver, they are also part of the caregiver's corresponding name relation. This provides the basis for *verbal communication* between child and caregiver. Thus, when either the child or the caregiver says "pat dog," their mutual response will be to orient to any one of the class of objects which they both name as "dog" (to the exclusion of other objects) and to engage in the further shared behavior of patting it. Clearly, although these words may be occasioned by some stimulus events and evoke some listener behavior that they do not fully share, it is the stimulus class categories and listener behavior that they do have in common that makes verbal communication possible. It also provides the basis for caregivers to extend membership of the classes embodied within the child's name relation and so to develop the child's verbal communication. Given that caregivers' orienting and other listener behavior are shared with many others in their verbal community, the child is now also well placed to begin to communicate with the community at large.

Verbal meaning. A basic and central feature of naming is that it relates to classes of stimuli (Mead, 1934, p. 88; Vygotsky, 1934/1987, p. 249); this, of course, is why the study of naming has such importance for the literature on stimulus equivalence and vice versa. Mead (1934, pp. 84–85) has maintained that when we name a stimulus, we in fact *re*-cognize it as an exemplar of a class and react to it in all of the ways we have learned, through the culture, as appropriate for that class of events; in this way we recognize each object as an instance of a universal. Similarly, Skinner (1957) has argued that "the verbal response *chair* is as abstract as *red.* It is not controlled by any single stimulus" (p. 110). According to Vygotsky (1934/1987, p. 285), it is this "generalized reflection of reality" that is the distinguishing feature of word meaning. In the present account, this is achieved through the circular relation between the stimulus class, the utterance, and the class of listener behavior, these being inextricably linked in the name relation. That is, when humans become speaker-listeners and name, they *mean.*

For each naming event, the initiating stimuli may occur in any modality, but the listener behavior that follows may produce stimulation involving all the modalities that have previously been engaged, as part of the name relation, with the class of objects or events named. For example, seeing a sign or picture or smelling her caregiver's baking may occasion for the child the spoken word "cake," which in turn may evoke in the child visions of cakes based upon all of the multifaceted views of cakes she has previously had; at the same time she may feel the crumbling texture as she touches cake and taste the sweetness as she bites into it. Such stimulation may, in turn, give rise to a range of sensations and emotional activity that reinforces naming. Thus, when the child names, she not only makes an utterance but also at the same time brings into being other behavior, either full-blown or incipient, overt or covert, all of which is bound up with the word.

The circular relation between, for example, seeing, saying and hearing, and seeing again with all of the attendant listener behavior and its consequences is what maintains the flow of listener behavior. As we have shown above, during each occurrence of naming, listener behavior changes and, in turn, alters the name relation itself; the name relation is therefore not so much circular as a *spiral of development* that grows in content with each occurrence or revolution.

Verbal thinking. It may be argued that thinking is simply behavior and is thus common to all animal species (see Skinner, 1957, p. 449). However, according to the present account the name relation represents a very special kind of behavior, with very special accomplishments and effects upon the rest of the behavioral system, that may be termed *verbal thinking.* In the final chapter of *Verbal Behavior,* Skinner (1957) describes the special properties of speaker-listener effects in speech for self that he also argues should be characterized as verbal thinking. We have attempted to demonstrate how naming is instrumental in bringing this about. We have also tried to show how, with the development of intraverbal behavior and speech for self, verbal thinking becomes a complex interaction between sometimes barely articulated words and the multimodal and crossmodal equivalences (cf. Bush, 1993) produced by their related listener behavior.

Reference and representation. It may be said that the name *re*-fers to a class of objects or events, because in a sense that is close to the derivation of this word, the namer is carried back via listener behavior to what is named (i.e., the referent). Similarly, it can be said that the name *re*-presents, *stands for, substitutes for,* or *specifies* the referent, because when naming occurs it may evoke in the namer and other listeners seeing or visualizing of the stimulus class to which the referent belongs and other related listener behavior. As we have shown, such representation occurs not only when the referent is present but also when it is absent.

Verbal consciousness. There is also a sense in which it might be said that naming enables us to *have representations* or to *have thoughts* of objects or events. When the child learns to produce her own verbal stimulus, such stimulation controls the occurrence of her own listener behavior, although whether she does so will, of course, be determined by the consequences of such behavior. Thus, whether or not the object itself is present, the child, through naming, can, for example, visualize it, hear it, touch it. (This in turn has profound effects upon the range of stimuli and listener behavior that will be related to the vocalization.) By reengaging the object within the ongoing name relation she might be said to *hold it in consciousness.* What she in fact holds or sustains is, of course, the class of stimuli produced by her own listener behavior. Clearly, organisms without naming skills cannot have this type of consciousness (see Mead, 1934, p. 95; Skinner, 1969, p. 233).

Before naming has been established, the child's listener behavior is dependent upon real-time stimulation from the environment, the effects of which may be fleeting. On the other hand, the stream of stimulation produced by the child's naming is to a large extent free of the spatial and temporal constraints that beset the real-life stimuli that are *re*-presented. For example, even if not able at a given moment to experience directly a cake, dog, her mother (or even a match-to-sample stimulus), the child may, nevertheless, through naming, visualize or imagine them. Therefore, when the child learns to name, this determines not only *what* she brings to consciousness but *when* she does so. In this sense speaker-listener effects have "the magic we expect to find in a thought process" (Skinner, 1957, p. 447). Being freed of real-time constraints in this manner, the child can now *re*-call or *re*-member objects, that is, keeping close to the derivations of these terms, use naming to "call back" or "call to mind" the listener behavior related to those objects (Mead, 1934, pp. 90–100).

Symbolic behavior. As we have shown, names can be said to refer to, represent, stand for, substitute for, specify, and recall classes of arbitrary but conventionally related objects and events. In this sense, naming is symbolic behavior (see Sinha, 1988). Once naming relations are established in the child's repertoire, a major step has been taken in transforming what is essentially a biologically based behavioral system, governed by unilinear three-term contingency relations, to one of much greater complexity in which bidirectional, socially shared relations between stimulus classes and behavior predominate, and objects and events are represented or held in consciousness in a way that transcends the spatial and temporal constraints that govern their occurrence in the *real* world. The name relation is the behavioral unit upon which this transformation is based.

APPLICATION OF THE NAMING ACCOUNT TO STIMULUS EQUIVALENCE

In the previous sections we have described how, via naming, the child's behavior that has been established with a single stimulus comes to generalize to stimuli that are physically very different and how, within particular contexts, she comes to respond to sets of different objects and events as interchangeable. It is phenomena of this kind that are the central focus of the literature on stimulus equivalence. But according to our account, the "emergent" behavior that occurs in these circumstances, although indeed not directly reinforced or trained, is simply a consequence of different stimuli being part of the same name relation. Might it not be the case then that humans' success on match-to-sample tests of stimulus equivalence is also directly attributable to the ways in which they name the stimuli?

Common Naming and Stimulus Equivalence

We will consider the operation of naming within the context of the two types of match-to-sample procedures commonly used to study stimulus equivalence: auditory-visual and visual-visual procedures.

Auditory-visual procedures. Many of the experimental studies of stimulus equivalence have used auditory-visual match-to-sample procedures, in which each stimulus class includes a dictated word (e.g., Green, 1990; Sidman, 1971; Sidman & Cresson, 1973; Sidman, Cresson, & Willson-Morris, 1974; Sidman, Kirk, & Willson-Morris, 1985; Sidman & Tailby, 1982; Sidman, Willson-Morris, & Kirk, 1986). For example, in Sidman's (1971) early study (see Figures 1 and 2) the sample stimuli were dictated words and the comparison stimuli were either pictures or printed words. As we have already shown, in such conditions subjects may echo the dictated words and, in so doing, learn to use the dictated word (e.g., "car") as their name both for the picture and the printed word. In support of this analysis, it should be noted that in the Sidman (1971) study, although the matching procedure did not require subjects to name the stimuli, all emitted the "correct" class names when presented with the pictures and the printed words. Clearly, although it might not be the experimenter's intention, these procedures are often effective means of establishing common names and, hence, for achieving success on equivalence tests (see pp. 206–207). Although since Sidman's (1971) experiment several studies have investigated equivalence classes using auditory-visual match-to-sample procedures, often using complex stimulus arrangements, the basic account of the role of naming illustrated in Figure 4 applies in principle to all of this research.

Naming tests in auditory-visual procedures. It is, of course, difficult when, as in these procedures, the experimenter provides the right conditions for common naming to be established, to argue that naming does not have a critical role to play in subjects' success on the tests for equivalence. Yet this is what a number of investigators contend. Their evidence is based almost exclusively on the finding that in postexperimental naming tests presented to subjects after completion of the match-to-sample procedures, some individuals do not reliably produce common names for the stimuli in the same class (Green, 1990; Sidman et al., 1985, 1986; Sidman & Tailby, 1982). There are, however, major problems with conclusions based on such evidence; these are considered below.

Visual-visual procedures. Other studies have used visual-visual procedures, which one might think would avoid some of the difficulties that are inherent in auditory-visual matching, especially if the stimuli used are abstract forms for which there are no existing conventional names (see, e.g., Figure 15, from Saunders & Green, 1992). In fact, however, stimulus arrays, or parts thereof, may

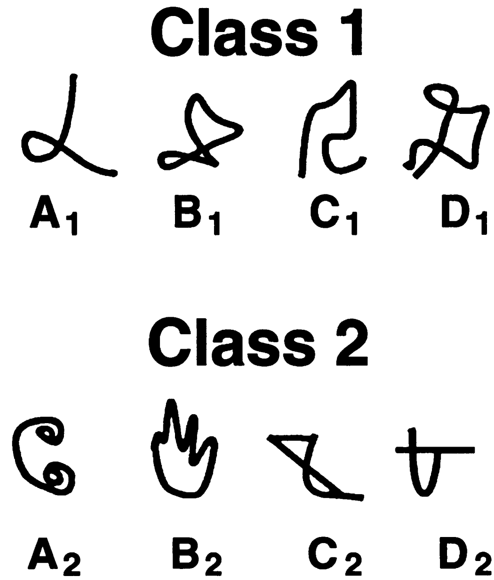

Fig. 15. An example of stimulus sets used in studies of visual-visual match to sample where A1, B1, C1, D1 and A2, B2, C2, D2 are the experimenter-defined stimulus Classes 1 and 2, respectively (after Saunders & Green, 1992, p. 229).

nevertheless occasion naming. That is, faced with novel "abstract" stimuli, the subject may search for features to which she can give a common name (see Wulfert, Dougher, & Greenway, 1991). In the Class 1 stimuli of Figure 15, for example, some subjects may "see" the C1 stimulus as resembling the letter R, which may occasion the verbal response "R" and related listener behavior; this may lead the subject to look for an R in other stimuli, particularly those that, when paired with C1 (as sample and comparison in the matching task), produce reinforcement. Thus one can "see" an approximation to R in the D1 and B1 stimuli and, if rotated, a lower case r in all four Class 1 stimuli. Similarly one can "see" a C or loop feature in the Class 2 stimuli. Clearly, the identification of a common feature in these stimuli is determined not just by their formal characteristics but by means of the class of listener behavior evoked during naming. For example, the name "R" evokes listener behavior not only to upper case but also to lower case exemplars and can thus embrace figures that show some resemblance to both. The subject's naming of the stimuli thus transforms the task from arbitrary to nonarbitrary match to sample.

Of course, just as identifying a nameable feature that can then be seen in other members of the class can help a subject to perform successfully on a matching task, so too a name that does not conform to class boundaries may actively impede successful performance. For example, in a study of equivalence formation in six 4- to 5-year-old children, Dugdale and Lowe (1990) found that when a common name was given for stimuli in each of two classes (named "omni" and "delta," respectively), for most subjects this facilitated both their learning of the baseline relations and, subsequently, their passing of equivalence tests. But for some subjects emergence of successful performance was delayed by their already having well-established names for some of the stimuli (e.g., "green" and "red" for green and red stimuli, respectively). In such cases existing individual stimulus names may prevent or delay the acquisition of the new experimenter-given common name. It follows that these "interfering" names must be attenuated or alternative verbal behavior devised in order to ensure success on the equivalence task (Dugdale & Lowe, 1990; cf. Bentall, Dickins, & Fox, 1993). It should also be noted, however, that because reinforcers are normally only contingent upon correct sample-comparison selections during baseline match-to-sample training, of the many names occasioned by stimulus features, only those that evoke listener behavior congruent with the stimulus class as specified by the experimenter will lead to responding that will be reinforced.

Whether or not naming is established in ways that facilitate the passing of equivalence tests is dependent on the particular training procedure used. Insofar as auditory-visual procedures have many of the characteristics of everyday naming (i.e., a word is spoken by the experimenter immediately prior to each of many presentations of a stimulus), then common naming should be established more easily with this method than with visual-visual procedures. In the latter procedure, rather than the experimenter providing the names at the outset, names are produced, over the course of the experiment and through interaction with the reinforcement contingencies, by the subjects themselves. According to this account, subjects on auditory-visual procedures should generally take less time to learn the baseline relations and be more successful on equivalence tests than subjects on visual-visual procedures. This result is just what is found in match-to-sample studies that have compared the two procedures (Green, 1990; Lipkens, Hayes, & Hayes, 1993; Sidman et al., 1986).

Naming tests in equivalence procedures. When subjects in studies of visual-visual match-to-sample have been presented with naming tests, they may have names for individual stimuli, but frequently they do not report a common name for each stimulus class; this observation has been interpreted as providing further support for the view that naming is not necessary for the formation of stimulus equivalence (Green, 1990; Lazar, Davis-Lang, & Sanchez, 1984; Sidman et al., 1986). However, the central difficulty that besets almost all studies, both auditory-visual and visual-visual, that purport to show that naming is not involved in successful performance on equivalence tasks is that they have not attempted to record subjects' naming behavior in the course of match-to-sample experiments but instead have relied upon postexperimental naming tests in which the subject is usually provided with one of the stimuli and is asked, for example, "What is it?" (Sidman et al., 1985) or "What is the name for this?" (Green, 1990). The names evoked under these conditions, however, may not correspond with the verbal responses of the subject during the experiment itself. This is shown in studies conducted by Lowe and colleagues (see Dugdale & Lowe, 1990): In two separate experiments, one with mentally handicapped adults (Hird & Lowe, 1985[4]; see also Hird, 1989) and the other with children aged 2 to 5 years old (Lowe & Beasty, 1987; see also Beasty, 1987), all verbalizations made by subjects during training and testing on match-to-sample tasks were recorded. Although for some individuals there was close correspondence between the names they produced on a postexperimental naming test and those they uttered spontaneously in the course of the experiment, for others the experimen-

[4] Hird, J., & Lowe, C. F. (1985, April). *The role of language in the emergence of equivalence relations I: Evidence from studies with mentally handicapped people.* Paper presented at the annual conference of the Experimental Analysis of Behaviour Group, York, United Kingdom.

ter's questions prompted very different names or even analytical descriptions of the stimuli of a kind not previously vocalized in the course of the experiment. The weakness of naming tests as evidence has also been highlighted by Stoddard and McIlvane (1986):

> Do these data [from naming tests] lay to rest the question of response mediation as the critical basis for stimulus equivalence? Probably not. . . . Some examples may serve to illustrate the difficulty of this research question. Suppose a given subject characterizes all the stimuli in the entirely visual classes with a common descriptive *adjectival* term, like "rounded," "pointed" or "pointing that way," perhaps derived from primary stimulus generalization . . . Alternately, suppose a common descriptive term, such as "Set 1" vs. "Set 2," was applied, as we do in talking about stimuli within classes. When asked the question, "What is it?" in relation to a given stimulus, perhaps the subject's verbal conditioning history had not prepared him or her to use descriptive terms as labels, leading to "I don't know" [its name] responses on the naming test. Would other methods of testing have evoked the descriptions? (p. 157)

But given that researchers record subjects' verbal reports and find evidence that some subjects do not use a common name or common description for all members of a stimulus class, would this justify the conclusion that naming is not necessary for the formation of equivalence classes? Some (Green, 1990; Lazar et al., 1984; Sidman et al., 1985, 1986; but see also Sidman, 1994, pp. 113, 305–307) have assumed this to be the case, but there are many other ways, apart from common naming, in which names might serve to bring about success on equivalence tests (see pp. 221–222, *Other Verbal Behavior* . . .). One such is intraverbal naming.

Intraverbal Naming and Stimulus Equivalence

How intraverbal naming can enable children to pass tests of equivalence is shown in the Lowe and Beasty (1987) study (see Beasty, 1987; Dugdale & Lowe, 1990), which recorded the spontaneous verbalizations of children aged 2 to 5 years old while they performed on a visual-visual match-to-sample task (see Figure 16). In the first training phase the children were taught to match a vertical line sample to a green, rather than a red, comparison (A1B1 relation) and a horizontal line sample to the red, rather than the green, comparison stimulus (A2B2). In the second training phase they were taught to match a vertical line sample to a triangle, rather than cross, comparison stimulus (A1C1) and a horizontal line sample to the cross (A2C2). Equivalence tests were then presented to assess whether the subjects could match green to triangle (B1C1) and triangle to green (C1B1) and match red to cross (B2C2) and cross to red (C2B2). Tests of symmetry were also performed to determine whether they could also match green to vertical line (B1 to A1) and red to horizontal line (B2 to A2) and match triangle to vertical line (C1 to A1) and cross to horizontal line (C2 to A2).

Of the 29 subjects of differing ages who participated, 17 passed the tests of equivalence following training on the AB and AC relations, success being related to age (see pp. 224, 225). Recordings of subjects' spontaneous verbal behavior showed the following: (a) During the training sessions, all subjects named individual stimuli as, for example, "up," "down," "cross," "triangle," "green," and "red" (for the vertical line, horizontal line, cross, triangle, green and red stimuli, respectively). (b) All of those children who were successful in the equivalence tests had previously, during training, intraverbally named the correct sample-comparison pairs: On A1B1 trials, for instance, some of the children, when presented with the vertical stimulus as sample and the green stimulus as one of the comparisons, responded "up green," and on A1C1 trials they said, in the presence of the vertical and triangle, "up triangle"; similarly, when presented with the horizontal stimulus, they said "down red" or "down cross" (see Figure 16). (c) Some subjects, when presented during baseline sessions with one of the stimuli in a particular class, responded by naming all three class members despite the fact that only two of these were present at the time. This also occurred during baseline and test trials in equivalence test sessions; for example, when presented with the vertical line (A1), 1 child responded "up green, up hat" (where her name for the vertical A1 stimulus was "up," for the B1 green stimulus "green," and for the C1 triangle stimulus "hat"); another

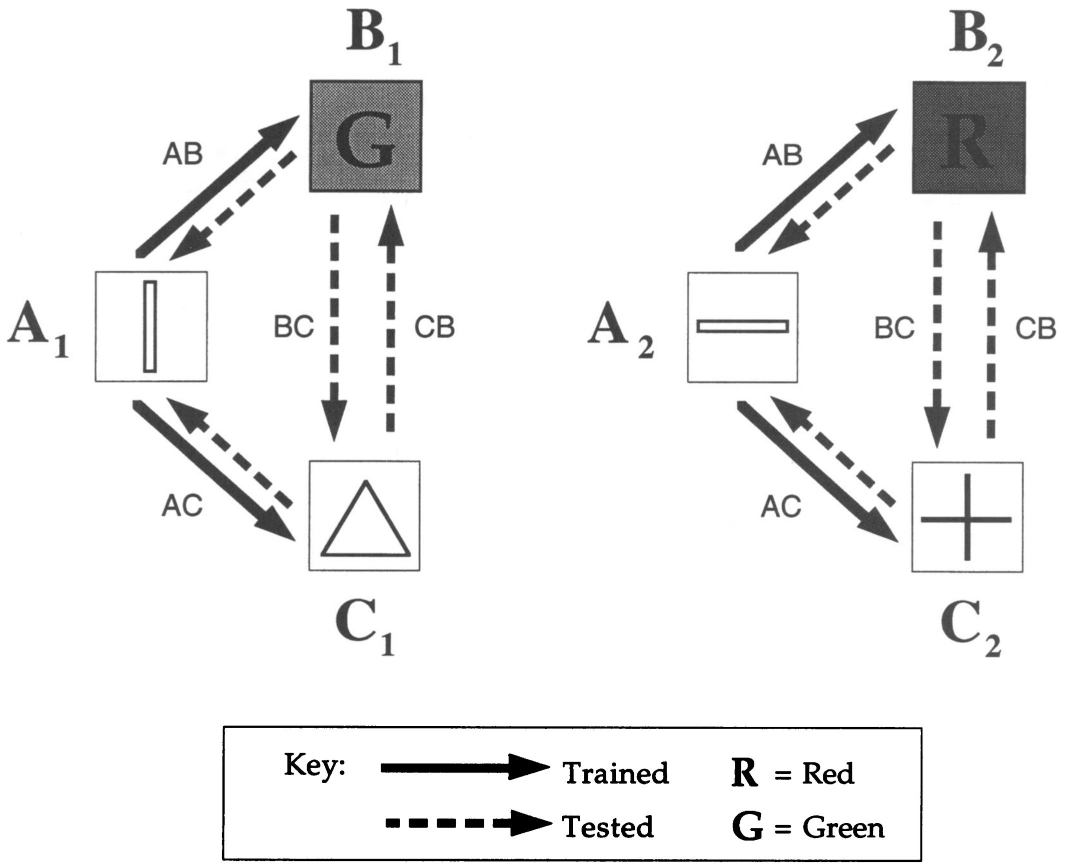

Fig. 16. The equivalence paradigm employed by Lowe and Beasty (1987). The arrows point from samples to corresponding comparison stimuli. Solid arrows indicate trained relations (AB and AC), and broken arrows depict relations assessed during testing (BA, CA, BC, and CB). The experimenter-defined stimulus Classes 1 and 2 are shown in the left and right displays, respectively.

child, when presented with the red stimulus (B2), said "down red cross," naming A2, B2, and C2, respectively.

How intraverbal naming of the correct sample-comparison stimulus pairs could give rise to success on the equivalence tests follows from our general account. In the course of training on the match-to-sample procedure employed in the Lowe and Beasty (1987) study and most others on equivalence, the subject is likely to name the stimuli, either overtly or covertly, when she sees them. Thus, as shown in Figure 17, when presented with the vertical stimulus as sample the child, like some of the subjects in the Lowe and Beasty study, may name it "up" and then press that response panel. When the green and red comparison stimuli then appear, she may initially name them both by saying "green red." If she then selects the red stimulus in response to her last saying "red," no reinforcer will be forthcoming and the probability of saying "red" and selecting red in the presence of the vertical stimulus will decline. If, however, on this or a subsequent trial with the vertical sample she says "green" and then selects the green key, this behavior will be reinforced and the probability of saying "green" and selecting the green key in the presence of the vertical will increase. As the child learns the AB relations, she will thus increasingly tend to name successful sequences of responding to stimuli (e.g., "up green" or "down red"). (This is a process similar to that discussed on pp. 209–210, *How intraverbals* . . ., and by Skinner, 1957, pp. 75–76, where the child comes to say "spoon fork" when regularly seeing both together.) In this case

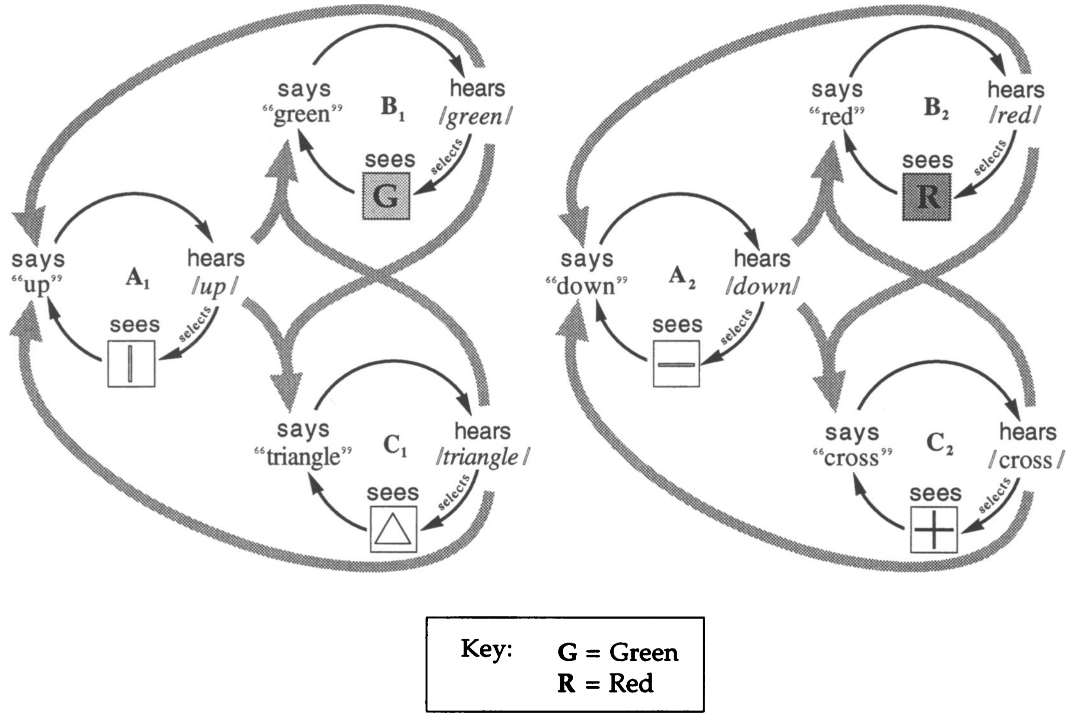

Fig. 17. Subjects' intraverbal naming of the stimuli in the Lowe and Beasty (1987) study. In learning baseline relations (AB and AC) the subject simultaneously learns bidirectional intraverbal name relations "up" ↔ "green," "up" ↔ "triangle," "triangle" ↔ "green" (left) and "down" ↔ "red," "down" ↔ "cross," "red" ↔ "cross" (right) between the stimuli (gray arrows). When the subject names any stimulus presented as sample, intraverbal naming of its other two class members is evoked; this, in turn, occasions selection of whichever of the two is presented as the comparison in that particular trial. Thus, through intraverbal naming, stimuli within a class become interchangeable in the context of match to sample.

the child continues to name the correct sample-comparison stimulus pairs because this behavior controls correct responding on the match-to-sample task (i.e., enables the child to "remember" what goes with what) and is thus reinforced through the experimental contingencies. As was frequently observed in the Lowe and Beasty study, the child may self-echoically repeat "up green up green up green," which establishes a bidirectional relation not only between the verbal responses "up" and "green," but also between their related listener behavior of responding on the vertical and green keys. So, as shown in Figure 17, upon testing for the symmetrical B1-A1 relation, the child, seeing the green stimulus (B1) as a sample for the first time, says "green"; the resultant verbal stimulus */green/* occasions intraverbally her saying "up" and hearing */up/* and then in turn selecting the vertical stimulus (A1). Similar relations will obtain when testing for symmetry between B2-A2 (i.e., red and horizontal stimuli). (It is also, of course, possible at this stage that other verbal behavior, e.g., "green goes with up" or "up goes with green," may be involved; see below.)

Intraverbally produced bidirectional relations between A and C stimuli may emerge in a fashion similar to those for A and B. At the start of training on AC relations the child, when presented with the A stimulus (e.g., the vertical), may continue for some time with AB verbalizations (e.g., "up green") but because B stimuli (e.g., green) never follow the A sample in these trials and only AC responding is reinforced, the child learns when given the A sample (e.g., vertical) to select the C stimuli (e.g., triangle) and at the same time to name intraverbally the correct AC stimulus pairs (e.g., "up triangle"). When AB and AC trials are then mixed with equal probability, as is standard practice in these procedures, each sample (A) name will intraverbally give rise to two different names of comparison stimuli (B and C) including their related listener behavior. Thus, as shown in Figure 17, when the vertical stimulus (A1) is the sample, the child may say "up green up triangle" or "up triangle up green"; because the vertical stimulus occasions "green" and "triangle" with similar probabilities, */up/* may also give rise to "green triangle," yielding now in response to the vertical sample the three-name intraverbal "up green triangle" (or "up triangle green"); intraverbal sequences of just this kind were articulated by subjects in the studies by Lowe and Beasty (1987) and Hird and Lowe (1985). With self-echoic repetition of these sequences, any of the A, B and C stimulus names may come to occasion the other two. At this point an intraverbal "equivalence" class has been formed, wherein the names that the subject has applied to the experimental stimuli in each class become interchangeable. This leads directly to success on formal tests of equivalence within the matching paradigm. Figure 17 shows, for example, that on CB test trials, when the child for the first time sees the triangle (C1) as a sample, she names it "triangle," which intraverbally occasions her saying "up" and "green." Having pressed the sample, the green (B1) and red (B2) keys appear as comparison stimuli: Hearing herself say */green/*, she orients to and selects the green, rather than the red, key. Similar relations should hold between B1-C1, C2-B2, and B2-C2 names and respective stimulus selection. Such behavior is taken to indicate that subjects have formed stimulus equivalence.

From intraverbal to common naming. There is, however, another verbal route that may develop in the course of learning these conditional relations. For example, if on A1-B1 and A1-C1 trials a subject names the stimulus pairs "up-green" and "up-triangle," respectively, then because "up" (the name of the nodal stimulus) is common, both the intraverbal name pairs may contract to the common name "up." This is particularly likely to happen with repeated presentations of A1-B1 and A1-C1 trials. Thus, as depicted in Figure 18, whenever not only the vertical stimulus but also the green or the triangle stimulus are presented all three may be named "up," a common naming strategy recorded for some of the subjects in the Lowe and Beasty (1987) study. Similarly, the horizontal, red, and cross stimuli may each occasion "down." As was shown earlier (see Figure 14), common naming brings with it novel behavior, in this case selecting the other within-class stimuli whenever one member of the class is presented as the sample, thus meeting all of the test criteria for stimulus equivalence.

Other Verbal Behavior and Stimulus Equivalence

So far we have shown how two particular forms of verbal behavior—common naming and intraverbal naming—can bring about success on tests of equivalence. But there are other possibilities. For example, the young children in the Lowe and Beasty (1987) study produced a variety of descriptions of the stimulus relations as they performed the task (e.g., "green means up," "green is up," "green is the same as the triangle," "what does red go with?" "they [pointing to the vertical and triangle] are both green"). Similar findings have been reported by Wulfert et al. (1991) who, in an interesting methodological departure for equivalence research, used a "think aloud" procedure modeled upon Ericsson and Simon's (1980) protocol analysis. The results of their first experiment with adult humans showed that subjects who formed equivalence classes described the relations among the stimuli in each class: They named and linked the stimuli with phrases such as "circle goes with the open triangle," which also occurred in more telegraphic intraverbal form (e.g., "circle triangle"), as in the Lowe and Beasty study. In addition, on equivalence test trials the successful subjects explicitly named the nodal stimulus (i.e., the sample stimulus that during training was common to all of the stimulus pairings within each class). As the study progressed, 2 of the subjects ceased to utter the names for the individual stimulus relations in each class and instead used a common "category" name. Those subjects who did not show equivalence did not describe the relation between stimuli within each experimenter-defined class but instead verbally linked together stimuli from different classes on the grounds that they belonged together as a compound (e.g., "Together they look like a person with a hat") or

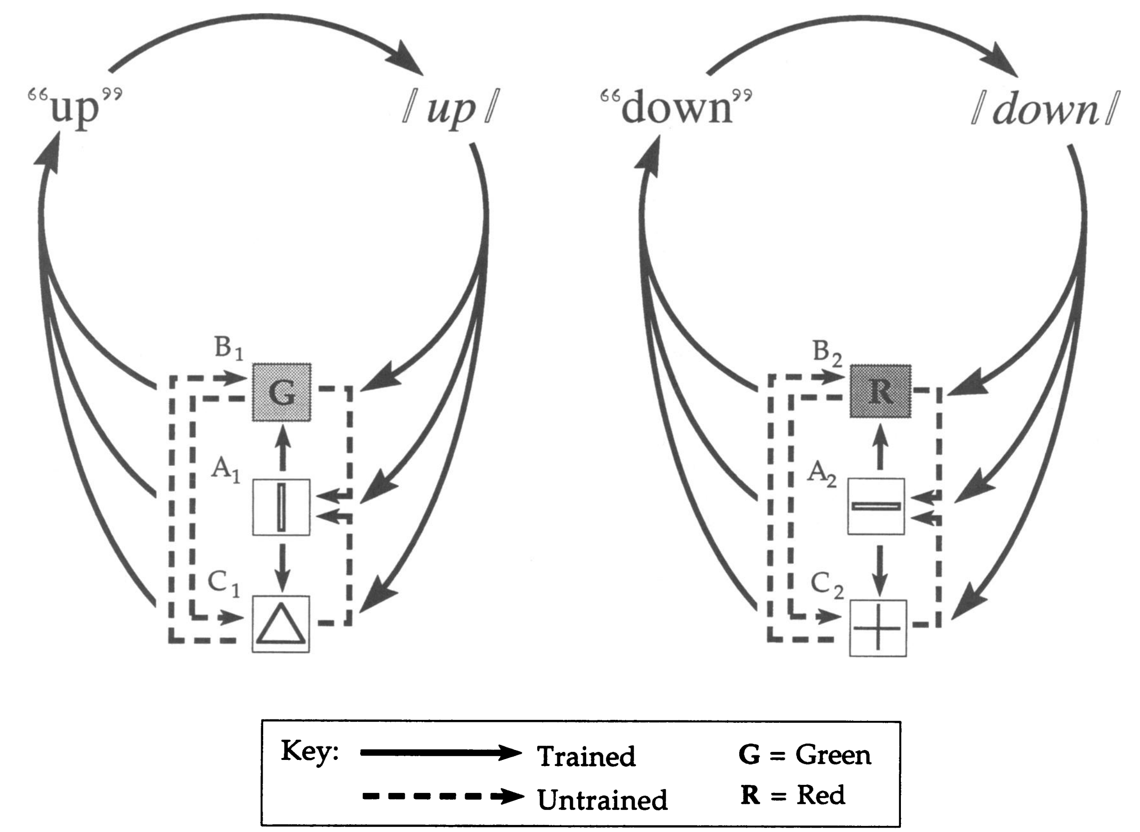

Fig. 18. When a subject comes to emit the common name "up" in relation to each Class 1 stimulus (left) and "down" in relation to each Class 2 stimulus (right), new relations between stimulus class members result (broken arrows), thereby fulfilling the criteria for stimulus equivalence.

referred to across-class common physical features of the stimuli, thus cutting across the stimulus class groupings as specified by the experimenter. This study, like that of Lowe and Beasty, shows how both intraverbal naming of the stimulus-comparison pairs and common naming can determine performance on these tests.

Naming tests, naming, and stimulus equivalence. It follows from the foregoing that if evidence were to be found that subjects in any given equivalence experiment did not have *common* names for stimuli in the same class, that would not, in itself, justify the conclusion that naming in some form is not necessary for success on these tasks. What the present analysis shows is that once language is established there may be, in addition to common naming, a large, possibly infinite, number of ways in which naming can enter into subjects' choices of stimuli such that they conform to psychologists' criteria for stimulus equivalence. If the supposed absence of common naming of stimuli within the experimenter-defined classes is the only developed argument against the naming hypothesis, it must be concluded that the latter is far from being disproved.

Key Tests of the Naming Hypothesis

A major virtue of the naming hypothesis of stimulus equivalence is that it gives rise to several clear predictions that are open to experimental disconfirmation. Fortunately, a number of them have already been submitted to experimental test:

Because they are lacking in naming skills, nonhuman organisms will generally fail tests of stimulus equivalence. There is no theoretical basis within current accounts of nonverbal animal learning for assuming that stimulus equivalence, at least as conventionally assessed, should ever arise (Catania, 1992, p. 156). For example, the three-term contingency, which is central to Skinner's (1938) account of operant conditioning, specifies a relation linking a discriminative stimulus, a response, and a reinforcer, such that in the presence of the stimulus the response is reinforced. The operant literature shows that such discriminative functions may take many forms and be of considerable complexity, but characteristically the direction of the relation between the discriminative stimulus and response is one way. Thus if standard match-to-sample procedures are used to establish contingencies with an animal subject (e.g., a pigeon) such that in the presence of a green key (the sample) a response on another key, a vertical line (correct comparison stimulus), is reinforced, then when the green stimulus is presented we would expect the probability of responding on the vertical stimulus to increase. There are no theoretical grounds, however, to expect that when we present the vertical as sample the animal will respond with high probability on the green comparison key. Indeed, it may be the very effectiveness of the three-term contingency that in part precludes animal species, other than humans, from success on equivalence tests; if organisms are locked into such unidirectional relations there is no opportunity or mechanism by which reversals can occur. On the other hand, most humans are, through naming, freed of the temporal and spatial constraints that govern discriminative control of animal behavior because they produce their own stimuli (e.g., names) that form reversible and other links between their behavior and stimuli in the environment.

Numerous experimental studies support this view and have shown that nonhuman animals may learn conditional discriminations readily, but without this resulting in stimulus equivalence. Despite concerted efforts, studies to date have failed to demonstrate equivalence with pigeons, cebus monkeys, rhesus monkeys, baboons, and chimpanzees (see D'Amato, Salmon, Loukas, & Tomie, 1985; Dugdale & Lowe, 1990; Hogan & Zentall, 1977; Holmes, 1979; Kendall, 1983; Lipkens, Kop, & Matthijs, 1988; Rodewald, 1974; Sidman et al., 1982). Although some investigators have claimed to find equivalence with animal subjects (McIntire, Cleary, & Thompson, 1987; Vaughan, 1988), others have argued that their data do not meet the necessary criteria for equivalence (see Dugdale & Lowe, 1990; Hayes, 1989; Saunders, 1989).

Recently, Schusterman and Kastak (1993), using a novel match-to-sample procedure, reported that a sea lion succeeded in passing tests of stimulus equivalence. Having first devised 30 potential three-member stimulus classes they designated 12 of these for training of symmetric and transitive relations and reserved 18 classes for equivalence tests. They trained AB and BC relations with all 30 classes and used the following procedure to train symmetry and transitivity on the selected 12: (a) AB training followed by BA ("symmetry") testing and training, (b) BC training followed by CB ("symmetry") testing and training, (c) AC ("transitivity") testing and training, and (d) CA ("symmetry") testing and training. The sea lion was then tested for CA (equivalence) on the 18 reserved stimulus classes, correct responding being reinforced throughout. Taking the first test trial for each stimulus class, performance was correct on 16 out of the 18 trials, which was significantly better than chance.

There are a number of distinctive features of this study that might throw light upon the sea lion's success where other animal species have failed. First, on all trials, the sample and comparison stimuli were simultaneously visible to the sea lion before it was released to respond to one of the comparison locations. Second, no sample response was required, the only response requirement being orientation to the left or right of release location such that the sea lion's nose broke the plane formed by the front of the correct comparison stimulus. Third, the incorrect comparison stimuli were randomly assigned and so differed from trial to trial, minimizing any build-up of CS− or negative discriminative stimulus control by particular comparison stimuli. Fourth, training was given on a subset of "symmetry" and "transitivity" relations; correct responding, including that on test trials, was reinforced throughout the study.

Whether these or other features might have brought about success on CA tests is difficult to assess on the basis of the limited procedural information available, but one possibility is that in combination they provided the conditions to establish each stimulus pair (e.g., within the AB and BC classes) as a compound stimulus that evoked (a) swaying or moving back and forth (which is food-related behavior in sea lions) across the two stimulus elements of the compound until the plane in front of the outer element was broken and the fish reinforcer delivered, and (b) as training progressed, the response of moving to the outer stimulus element (comparison) of the compound. During "symmetry" (BA and CB) training, with continuous reinforcement for correct responding, these effects of stimulus pairs operating as compounds should be strengthened. On the basis of studies that have demonstrated "associative transitivity" in match to sample (D'Amato et al. 1985; Steirn, Jackson-Smith, & Zentall, 1991; see Zentall & Urcuioli, 1993), such that when AB and BC are trained, the AC relation is present upon testing, it might be expected that the sea lion would pass the test of AC transitivity; this was indeed found. But given that the AC stimulus elements also come to function as a compound and that, whether presented as AC or CA, the animal moves towards the outer element of that compound (as described above), this may be sufficient to account for successful performance on the continually reinforced CA (equivalence) test trials.

This account is, of course, highly speculative and needs to be submitted to experimental test. Indeed, the study itself remains to be replicated. Until then it may not be possible to determine whether Schusterman and Kastak's procedure constitutes a demonstration of learned higher order generalized equivalence (Boelens, 1994) or whether simpler learning principles such as those outlined above apply. It should also be noted, however, that if a particular nonhuman animal in a particular match-to-sample context ever did succeed in passing tests of stimulus equivalence, it would not mean that the functional determinants of the behavior would be the same as those which enable verbally competent humans to succeed on these tasks. To assume the determinants were the same would be an example of a formalistic fallacy (Skinner, 1969). This and related issues are discussed on page 233.

Humans who are lacking the prerequisite naming skills will generally fail tests of stimulus equivalence. One of the most fruitful ways to test this prediction is with young children who have not yet learned to name or in whom naming skills are not yet well established. Unfortunately, not very much research on stimulus equivalence has been conducted with very young children, but studies that do exist point to a close correlation between the development of language and success on equivalence tasks. For example, a study by Devany et al. (1986; but see also Augustson & Dougher, 1992) tested for stimulus equivalence in three groups of subjects: normal 2-year-old children, 2- to 4-year-old mentally handicapped children with functional spontaneous speech and signing, and 2- to 4-year-old mentally handicapped children with no functional verbal skills. Both of the first two groups (i.e., normal and mentally handicapped with language) passed the equivalence tests, whereas the mentally handicapped subjects who had no language failed. In a study of normal and hearing-impaired children, Barnes, McCullogh, and Keenan (1990) have reported a similar relation between verbal ability and success on tests of equivalence.

Because language development over the first few years of life in young children is correlated with chronological age, we would expect, according to the present account, to observe more failure on equivalence tests by children in the younger age ranges and more success by those who are older and have acquired better naming skills. This was investigated in the study by Lowe and Beasty (1987; see above), whose subjects were in three different age groups: 4 to 5, 3 to 4, and 2 to 3 years old. Following standard training on the baseline conditional discriminations, (a) all 10 of the 4- to 5-year-old children passed tests of equivalence, (b) half of the 12 subjects aged 3 to 4 years old succeeded, and (c) only 1 out of 7 of the 2- to 3-year-old subjects passed (see next section).

Teaching subjects particular name relations for the stimuli used in match-to-sample procedures may be a powerful determinant of subsequent performance on equivalence tests. Dugdale and Lowe (1990) have reported that when normal 4- to 5-year-old children who fail tests of equivalence are subsequently taught a common name (e.g., "omni" or "delta") for the stimuli in each experimenter-defined class, they then go on to pass the tests. A common naming intervention has also been used by Eikeseth and Smith (1992) in their investigation of visual-visual equivalence in 4 autistic children. The subjects' ages ranged from 3.5 to 5.5 years but all showed evidence of deficits in language skills compared to normal children. Having learned the baseline conditional discriminations, all 4 children initially failed the tests of equivalence; when common naming of the stimuli in each class was then introduced, 2 of the subjects passed and a 3rd performed at well above chance levels. The 4th subject, Rory, was the only one to perform at chance levels on the tests and also had the lowest level of language development in the group, as indicated by both expressive and receptive measures. In another phase of the experiment and outside the match-to-sample format, the same 4 subjects were taught names for entirely new stimuli. On subsequent match-to-sample tests, 3 subjects demonstrated emergent relations between the stimuli that had been assigned a common name, thus meeting the criteria that would normally be set for equivalence with match-to-sample procedures, except that in this case none of the baseline conditional relations had been trained with these stimuli prior to testing. In this phase, Rory was again the one with whom the procedure was least successful; however, when the procedure for teaching him names was modified, emergent relations were also facilitated in this subject. This second phase is a good experimental demonstration of a phenomenon that occurs during normal language development in children (see pp. 205–207, *Naming and emergent behavior*), and the study as a whole shows that common naming can be a powerful intervention in bringing about equivalence even in autistic children.

Saunders, Saunders, Williams, and Spradlin (1993) presented evidence showing that, for subjects with mild retardation, match-to-sample training involving four pairs of sample and one pair of comparison stimuli (comparison as node) was much more successful in yielding stimulus equivalence than procedures with four pairs of comparison stimuli and one pair of samples (sample as node). Success on the comparison-as-node procedure, however, was shown to rely heavily upon the subjects being given verbal instructions and names for the stimuli. Subjects who were not provided with names had a much higher failure rate than those given names; when subjects in the nonnaming group, who had initially failed the equivalence tests, were subsequently instructed to name the stimuli, they also went on to pass the tests. Saunders et al. recognize that naming instructions have an important role in bringing about these effects and suggest that the comparison-as-node procedure results in "anticipatory naming of the correct comparison for each sample. Thus, every sample within a class would control a common naming response" (p. 732).

The question, however, is how this common naming has its effects: Saunders et al. (1993; see also Eikeseth & Smith, 1992) suggest that when different stimuli evoke the same name, this brings about a functional stimulus class that then somehow results in equivalence class formation. However, as we have already shown in the first section of this paper, to establish a common response to different stimuli and thus a functional class is not sufficient to yield stimulus equivalence. To provide an explanation of the latter, including the findings of the study by Saunders et al., requires an account of naming not simply as speaking but as speaker-listener behavior, with all of the bidirectional effects thereby entailed.

Evidence that interventions based upon intraverbal naming can be very effective determinants of outcomes on equivalence tests comes from the Lowe and Beasty (1987) study in which the 12 children who initially failed the equivalence tests were subsequently taught to name the sample-comparison stimulus pairs. On A1B1 baseline trials (see p. 218) they were taught to say "up-green," on A1C1 trials "up triangle," on A2B2 "down red," and on A2C2 "down cross." Teaching this intraverbal naming, which was similar to that spontaneously produced by the children who had passed the equivalence tests, led to 11 of the 12 children passing the BC and CB tests. The one 2-year-old child who failed the tests was also the only child who failed to learn the sample-comparison names in the time available.

As well as leading to success, some verbal interventions may also lead to failure on equivalence tests. In a study of match-to-sample performance in normal adults Dickins, Bentall, and Smith (1993) first taught baseline relations, after which subjects in one group were taught intraverbal names that linked stimuli across rather than within experimenter-defined classes and subjects in a second group were taught intraverbal sequences unrelated to on-task stimuli. The group of subjects taught across-class intraverbal sequences were much less successful on subsequent tests of stimulus equivalence than were control-group subjects. This study shows that intraverbal naming can work for or against success on tests of stimulus equivalence depending on whether or not the intraverbal sequences that are formed before such testing are congruent with experimenter-defined classes.

In a recent paper, Mandell and Sheen (1994) set out explicitly to test the naming hypothesis, reasoning that if naming is an important determinant of stimulus class formation, then whether or not the stimuli in match-to-sample procedures are easily nameable should be predictive of performance on equivalence tests; the more nameable the stimuli, the more likely it should be that subjects would be successful. In a visual-visual match-to-sample study with normal adults, subjects saw three kinds of sample stimuli that varied in pronounceability: (a) phonologically correct pseudowords (e.g., SNAMB), (b) phonologically incorrect words (e.g., NSJBN), or (c) punctuation marks (e.g., +]*^ !). Subjects in the group that was exposed to the pronounceable stimuli demonstrated equivalence class formation more quickly and with fewer errors than did other subjects. Also, some of the subjects who were not provided with sample stimuli that were easily pronounceable nevertheless found other more idiosyncratic means of naming the stimuli (e.g., naming HCKTR as "HECTOR" or naming just the first letter of each nonphonological word). In a second study, subjects were pretrained to apply names to nonphonological words. As a result, their subsequent match-to-sample performance, particularly the development of stimulus equivalence classes, was considerably enhanced compared to the performance of subjects without such pretraining.

Overview. The studies reviewed above show that interventions that train common naming, intraverbal naming, or other naming behavior to relate the experimental stimuli are very effective in determining success on equivalence tasks. They also show that, to ensure success, it is not sufficient for subjects simply to have naming skills (they might all have these) but more specifically, their stimulus class naming must be congruent with the experimenter-defined classes. The present account of match-to-sample performance not only makes sense of the data from equivalence studies but is also consistent with a wider literature that shows many differences between behavioral relations in humans and nonhumans that are attributable to the role of language (Bentall, Lowe, & Beasty, 1985; Catania, Matthews, & Shimoff, 1982; Hayes & Hayes, 1992; Horne & Lowe, 1993; Le Francois, Chase, & Joyce, 1988; Lowe, 1979, 1983, 1989).

It has been suggested (Hayes, 1994; Hayes & Hayes, 1992; Sidman, 1994) that using language or naming to explain findings from match-to-sample studies is reminiscent of mediational models prominent in earlier decades. Mediated generalization theory (Cofer & Foley, 1942) was used to deal with a set of behavioral effects that were also termed *equivalence,* although they did not conform exactly with the definition of that term put forward by Sidman, and were studied by a different methodology, usually paired-associate learning (Jenkins, 1963; Jenkins & Palermo, 1964; Sidman, 1994). This was an associative account that used the paradigm of Pavlovian conditioning, particularly higher order conditioning, to make inferences about Pavlovian conditioned responses that supposedly mediated stimulus presentations, enabling symmetry, transitivity, and equivalence to emerge. It was essentially a stimulus-response chaining model, and like any such account it had great difficulty in dealing with the kinds of stimulus-stimulus reversals termed *symmetry.* Consequently, its advocates had to appeal to backward conditioning (Ekstrand, 1966), normally a very weak effect if it exists at all, and chaining to explain what were very reliable and robust phenomena (Jenkins, 1963). Clearly, the present account has little in common with traditional mediated generalization theory; it is not based on classical conditioning nor does it involve appeals to backward conditioning, chaining, or any of the other associative mechanisms of that theory. Indeed the primary role of naming should not be viewed as *mediating* the establishment of stimulus classes: Naming *is* stimulus-classifying behavior (see pp. 207–208, 213–215, *Verbal communication, Verbal meaning*). But the history of mediated generalization is an interesting one that has implications for current theories of equivalence, to which we shall return below.

In addition to generating falsifiable predictions, any explanation of stimulus equivalence should be able to account for the existing experimental data. The naming hypothesis succeeds on both these counts, although it remains, of course, open to experimental disconfirmation. We shall next consider alternative explanations of equivalence put forward by Sidman and by Hayes and colleagues.[5] In what follows we outline briefly the main features of these two accounts and subject them to critical but, we hope, constructive scrutiny, the aim being to further debate. We apologize in advance for any errors or misconceptions in our appraisal; undoubtedly, if there are any such, they will be clarified in the commentaries to this article. We later discuss features that are common to all three accounts and suggest ways in which further experimental work might help to achieve greater agreement between them.

Sidman's Theory of Equivalence

According to Sidman, equivalence (like reinforcement, discrimination, etc.) represents a primitive function not derivable from other behavioral processes (Sidman, 1992, p. 22). In his recent book (Sidman, 1994), he describes in some detail the conditions that give rise to equivalence relations and, departing from his earlier view (e.g., Sidman, 1986) that equivalence is established by four-term contingencies, concludes that three-term, or perhaps even two-term, contingencies could suffice. Whereas his earlier account was concerned with stimulus-stimulus relations, he now proposes that as a result of their participation in reinforcement contingencies, both stimuli (whether discriminative, conditional, or reinforcing) and responses become members of an equivalence relation. Thus, within the event pairs that define the equivalence relation, the distinction between stimulus and response loses significance; indeed, as he puts it, "Equivalence relations have their own defining characteristics, none requiring the stimulus/response dichotomy" (1994, p. 386).

It is important to note that, for Sidman,

> Strictly speaking, reinforcement contingencies do not create equivalence relations; rather, they create prerequisites, or the potential, for demonstrating the properties that define an equivalence relation. Additional factors, like the test conditions, contextual control, and a subject's behavioral history will help determine whether and how that potential is realized. . . . An equivalence relation, therefore, has no existence as a *thing*; it is not actually *established, formed,* or *created.* It does not *exist,* either in theory or in reality. It is defined by the emergence of new—and predictable—analytic units of behavior from previously demonstrated units. (1994, pp. 387–388).

Because responses as well as stimuli enter into equivalence relations, functions possessed by any one element of a reinforcement contingency giving rise to equivalence will also be possessed by other elements within it (1994, p. 392). Thus, discriminative stimuli will function as reinforcers, and reinforcers will function as discriminative stimuli. Whereas behavior analysts, including Sidman himself, have previously viewed conditioned reinforcement as a basic nonderived stimulus function, according to this account conditioned reinforcement is derived from equivalence relations (1994, pp. 391–393). Sidman proposes, furthermore, that the prerequisites for an equivalence relation may also arise during Pavlovian or respondent conditioning. Indeed, he suggests that Pavlovian conditioning may itself be a derived phenomenon that arises from the establishment of equivalence relations between pairs of stimulus events in conditioning procedures (1994, pp. 403–404). Thus, a stimulus paired with an unconditioned stimulus may become a conditioned stimulus by virtue of the participation of both in an equivalence relation.

To establish which particular stimulus classes will arise from particular reinforcement contingencies is not, however, a straightforward matter. For example, according to Sidman, because responses and reinforcers both enter into equivalence relations, during training of the conditional relations A1B1 and

[5] We are grateful to Murray Sidman and to Steve Hayes for their very helpful and constructive comments on some of the descriptive material on their accounts presented here. Any remaining errors of interpretation are entirely our responsibility.

A2B2 one large equivalence class (i.e., A1B1A2B2) *must* emerge if a common reinforcer, a defined response (e.g., key pressing), or both are employed throughout the procedure (Sidman, 1994, p. 408). The problem then is to account for what appears to be, as Sidman himself acknowledges, "an immense gulf between theory and data" (1994, p. 410), that is, that most studies (at least with human subjects) repeatedly fail to show this merging of classes but show instead "success" on experimenter-defined tests of equivalence. Sidman's explanation is that the incompatibility between the reinforcement contingencies and the formation of an overarching equivalence class causes the "selective dropping out" of common elements, that is, the response and reinforcer from the prerequisite class (1994, p. 411). Similarly, given that the experimental context can enter into equivalence relations and is common to all of the other experimenter-defined stimulus classes, it likewise should condense all of the classes into one, but in fact does not. Here, Sidman maintains that because this would wipe out differential control by discriminative stimuli in each three-term unit and by conditional stimuli in each four-term unit, the subject would be unable to meet the terms of the contingency and because the contingency "calls for differential control" (i.e., what is termed *class intersection* in set theory) this takes priority over the formation of the overarching stimulus class (i.e., class union) so that the context also drops out of the equivalence relations (1994, p. 530). He also argues that these overarching stimulus classes may be prevented from forming in the first place by the employment of different reinforcers and defined responses for each conditional relation (1994, p. 413).

Having subjects name the stimuli within each conditional relation may, in Sidman's view, be another way of either preventing or breaking down all-inclusive equivalence relations. Thus, in the example given above, if subjects name each of the A1 and B1 stimuli as "X" and the A2 and B2 stimuli as "Y," this should result in the establishment of the A1B1 and A2B2 equivalence relations because, according to Sidman, the different naming responses "X" and "Y," like any other differentiated response, facilitate class intersection (1994, p. 414).

Sidman also acknowledges that verbal rules can establish equivalence relations, although rules are not always necessary (1994, p. 509) and, in any case, he believes that appealing to rule following as an explanation begs the question as to where rules come from in the first place (Sidman, 1992, pp. 21–22). According to his account, it is the formation of equivalence relations that makes rule-governed behavior possible. He maintains that when naming or more complex verbalizations such as rules become members of an equivalence class, they become indistinguishable from other stimulus and response events and, as such, do not have a special mediating function. This, he believes, allows one to dispense entirely with the notion of verbal *mediation* of equivalence relations (Sidman, 1994, pp. 510–511).

In Sidman's view, because equivalence is an evolutionary given for which verbal skills are not necessary, it may occur in a range of animal species, although its generality remains to be established (1994, p. 390). Indeed, he suggests that "species differences need not be absolute but may depend on the ethological validity of the stimuli and functions being examined"(1994, p. 164). Failures to demonstrate equivalence with nonhumans may, he believes, be due to features of the standard conditional discrimination procedure employed in equivalence studies (1994, pp. 166–175).

Like many theoretical accounts, Sidman's has evolved to accommodate empirical findings that do not fit easily with his initial formulations. The result, described in great detail in his 1994 book, is an extraordinarily ambitious revision of existing behavioral theory in which the notion of equivalence becomes a core explanatory construct from which is derived, not only success on match-to-sample tests, transfer of function, and linguistic achievements, but also a range of what have hitherto been regarded as basic learning phenomena including conditioned reinforcement and Pavlovian conditioning. The critical tests for any grand theory such as this, however, are (a) how it relates to empirical data and (b) whether it is internally consistent. We contend that Sidman's theory has problems on both counts, only some of which we will deal with here.

If equivalence is a given, why is it rarely, if ever, found in nonverbal animals? On the one hand, Sidman professes not to know for which animal species equivalence is a given but, on the other, his view that conditioned reinforcement and Pavlovian conditioning are derivatives of equivalence implies that species that show evidence of such conditioning processes should also show equivalence. This, of course, would apply to a vast range of animal species, but for none of them, apart from humans, do we have reliable evidence of equivalence.

Nevertheless, for Sidman, equivalence is a given for the human species at least. But the empirical data show that success on equivalence tests is strongly related to the development of linguistic skills; children lacking the necessary level of verbal skill fail these tests. We have difficulty seeing how developmental differences like these can be explained by a theory that assumes equivalence as a given for *Homo sapiens* in general.

In view of the developmental data, it is paradoxical that, as an explanation of why some adult human subjects fail tests of equivalence, Sidman has suggested that because equivalence is a primitive stimulus function, it emerges first in early childhood and is only later broken down or circumscribed by verbal rules (1992, p. 22). Once again there are no experimental data to support this surmise; on the contrary, the available evidence indicates that equivalence is absent early in human development but is facilitated by later language learning. A further paradox, of course, is that the domain most free of verbal rules, namely nonhuman animal behavior, is just where equivalence is most difficult to obtain.

Sidman's general treatment of verbal rules appears to contain further inconsistencies. At times he maintains that, when they are members of an equivalence class, verbal rules are no different in function from other responses and stimuli and thus have no special mediational role (1994, pp. 510–511), whereas at other times he seems to ascribe a special role to verbal repertoires. For example, in criticizing Hayes' relational frame theory he writes, "I find it difficult to see how a common response (equivalencing?) to exemplars that have nothing in common except the relation could arise in the absence of a highly complex verbal repertoire" (p. 556). But he does not explain how such a "complex verbal repertoire" would enable subjects to behave in that way. Nevertheless, whatever his precise explanation of verbal rules and their relation to equivalence, one can conclude from Sidman's account that there are at least two kinds of equivalence, namely, that which arises directly from experience with contingencies (i.e., contingency generated) and that which is established by verbal rules or names (i.e., rule governed or verbally controlled; Sidman, 1992, pp. 21–22, 1994, pp. 305–306; see also Pilgrim & Galizio, 1995). We will return to this distinction later.

Not only does it appear that equivalence is not a given for all nonhuman species or even for all individual humans, but for any particular human it does not appear to be a given at all times during testing. As several studies have shown (see Sidman, 1994, p. 273), it is often the case that subjects initially fail to pass tests of equivalence but, as testing continues, performance indicative of equivalence relations emerges. Sidman suggests that this delayed emergence is due to interference from other equivalence relations established outside of, or even within, the experimental setting:

> A well-designed test will arrange test trials so that the experimentally established equivalence class provides the only basis for classification that remains possible—that "works"on every trial. Thus, the grounds for relating the sample and a comparison may vary from one test trial to the next until finally, the subject hits on a consistent basis—the experimentally established equivalence relation that remains possible from trial to trial. (1994, p. 512)

But if, as is often the convention, testing takes place in the absence of reinforcement or empirical feedback of any kind, how is it that subjects can have a "classification" that can "work" or can vary their responses until they "hit on a consistent basis"? (see Pilgrim, Chambers, & Galizio, 1995). This is just the kind of behavior we would expect in organisms that are able to name the stimulus pairs or formulate rules for responding to them that they can then proceed to combine and recombine until they formulate a consistent rule for responding on all of the test trials (or, as Saunders & Saunders, 1995,[6] have suggested, until the experimenter ceases to present the test trials). Certainly, it is not clear from Sidman's account how a nonverbal organism or an organism behaving nonverbally could engage in behavior of this kind.

One of the most radical features of Sidman's new account of the relations between events in an equivalence class is the removal of the distinction between responses, including naming and verbal rules, on the one hand, and stimuli, both discriminative and reinforcing, on the other. This innovation was prompted, in part, by experimental data showing that equivalence class membership can include reinforcing stimuli (see McIlvane, Dube, Klederas, de Rose, & Stoddard, 1992). In our view, however, it gives rise to serious and far-reaching conceptual and empirical problems. At the most basic level, removal of the stimulus-response dichotomy appears to remove a distinction between behavior and environment upon which behavior analysis, as well as many other sciences, are founded. It might be countered that, because most of behavior analysis is based upon the study of the behavior of nonhuman species under contingencies of reinforcement that do not give rise to equivalence relations in those species, this issue does not arise except in the case of species for which equivalence is a given (i.e., humans). But to argue thus would be to severely limit the generality of Sidman's theory, and difficulties vis-a-vis human behavior, particularly human language, would remain. These difficulties will be considered in detail below, following our appraisal of Hayes' account of equivalence.

In summary, what began as a description of novel behavioral relationships on match-to-sample tasks has now evolved into a very general theory that embraces most aspects of behavior analysis. It appears to us, however, that as the scope of the theory has extended, the theory has become increasingly removed from empirical foundations. Equivalence has become a behavioral primitive that is not found where we should most readily expect it, namely, in nonhuman animals and human infants. The very experiments that gave rise to the concept of equivalence now constitute problem cases or exceptions to the general rule that it is overarching classes, composed of all the experimental stimuli that should emerge, rather than the experimenter-defined classes. Sidman's explanation offered for this paradox, including his hypotheses about common reinforcers and responses "dropping out" and competition between the three-term unit and the overarching class, seems to us to be vague with respect to the behavioral principles involved and lacking empirical support. For a behavioral primitive, from which so many other behavioral phenomena are supposedly derived, true equivalence is remarkably elusive.

Hayes' Theory of Equivalence

Hayes' relational frame theory has been outlined in several papers (e.g., Hayes, 1991, 1994; Hayes & Hayes, 1989, 1992), so only a brief summary will be presented here. A major distinguishing feature of Hayes' view, in common with the present account but in contrast to that of Sidman, is that it explains success on equivalence tests in terms of the prior learning history of the subject. For Hayes, this involves a history of what is termed *arbitrarily applicable relational responding*, which entails "responding to one event in terms of the other based on contextual cues to do so. It is a pattern of the mutual transformation of stimulus functions" (Lipkens et al., 1993, p. 204). The theory is based upon a few core ideas. Given that human and nonhuman species can learn to respond to nonarbitrary relations between stimuli, it is argued that perhaps some species can learn to respond to relations between stimuli when these relations are not defined by the physical form of the stimuli but by contextual cues. Because only contextual cues are required, such relational responding is held to be arbitrarily applicable to any event. An analogy is drawn with the findings of the literature on generalized imitation (e.g., Gewirtz & Stingle, 1968) that indicates that organisms can learn overarching behavioral classes. The action of relating arbitrary stimuli in equivalence tasks, it is proposed, may be a similarly learned overarching class of instrumental behavior, which Hayes (1992, p. 110) terms *equivalencing*.

[6] Saunders, R. R., & Saunders, J. M. (1995, April). *The roles of generalised conditional responding and chance in the emergence of equivalence-indicative performances.* Paper presented at the annual meeting of the Experimental Analysis of Behaviour Group, London.

Arbitrarily applicable relational responding has three primary properties. The first of these is *mutual entailment* and involves responding to one event in terms of the other, and vice versa. So if A is better than B, it is mutually entailed that B is worse than A. Mutual entailment is the generic case of what is termed *symmetry* in the equivalence literature (Hayes, 1994, p. 11) in which A is the same as B and, through mutual entailment, B is the same as A. The particular relation (e.g., sameness, opposition, distinction, etc.) between events is controlled by contextual stimuli. The second is *combinatorial mutual entailment,* according to which if A is related in a particular way to B and B is also related to C, then (in addition to the mutual entailment of relations between A and B and B and C) a combinatorial derived relation is mutually entailed between A and C. Combinatorial entailment is the generic case of what are termed *transitivity* and *equivalence* in the equivalence literature (see Hayes, 1994, p. 11). The third property is *transformation of stimulus function,* which specifies that in a given context, if A is related (e.g., by opposition) to B and, in addition, A is given a nonrelational stimulus function, then this will result in a derived nonrelational stimulus function for B, in accord with the specified relation. The nonrelational functions of A that are derived for B will also be under contextual control.

The term *relational frame* (or framing relationally) refers to arbitrarily applicable relational responding that shows the three qualities outlined above. According to Hayes (1994, p. 28), one such frame, that is, the *frame of coordination* or sameness, establishes equivalence classes.

What is the history? Although the theory proposes that subjects require a history of examples of reinforced relational responding in order to abstract a relational frame and show equivalence, precisely what this history should be is not clear. Hayes (1989, p. 391) argues that one possible approach with nonhumans may be "to provide an extensive reinforced history with symmetrical relations" after which equivalence might emerge. On the other hand, Hayes and Hayes (1989, p. 174) propose that "a child given only a history of arbitrary matching-to-sample that reinforced symmetry, reflexivity and transitivity, could derive the frame of coordination and show equivalence classes." And yet again, Hayes (1991, p. 25) claims that equivalence emerges because "mutual entailment, combinatorial entailment, and transfer of function are *directly* trained." This latter view is elaborated by Hayes and Wilson (in press), who suggest that this might involve, with different combinations of stimulus pairs, the direct reinforcement of symmetry, transitivity, and *equivalence*; they also suggest that reinforcing symmetry might be enough to give rise to equivalence but that "some small amount of training in combinatorial entailment will probably also be needed." Although Hayes (1994) favors the last of these three possibilities, the theory itself does not indicate why one rather than another of these histories would be sufficient to yield a frame of coordination (i.e., equivalence).

How does the history work? This difficulty arises from the fact that the theory does not clearly specify what are the behavioral principles that govern the establishment of relational frames. An example of the kind of history that should bring about symmetry or mutual entailment is held to be one in which an organism is presented with sample-comparison stimuli such that the A $\rightarrow$ B relation is reinforced, and then the reversal B $\rightarrow$ A, then C $\rightarrow$ D and D $\rightarrow$ C, and so on. At some point, it is argued, the organism, when trained on X $\rightarrow$ Y, will show the derived relation Y $\rightarrow$ X; thus generalized symmetrical responding has been established. Apart from characterizing this behavior as an overarching response class that occurs in the presence of contextual cues (as is, of course, true of all operant behavior), and appealing to an analogy with generalized imitation, Hayes provides no further description or functional analysis of the behavior involved. The problem with the imitation analogy is that imitation does not have any of the defining features of relational framing (see Skinner, 1953, pp. 119–122) and hence does not clarify the behavioral principles involved in abstracting a frame of coordination or sameness from a history of reinforced reversals of stimulus pairs. This is not, of course, to assert that success on tests of equivalence cannot ever be brought about by histories of relational responding which do not involve naming, but merely that, were such a phenomenon ever to be convincingly demonstrated in a manner that ruled out known behavioral principles, relational frame theory could provide little by way of explanation (see Sidman, 1994, p. 557).

Naming as the paradigm case? In all of Hayes' writings, the only specific example of a history that is given from real life to account for the initial establishment of any relational frame is for the frame of coordination. This example is described in a number of papers (Hayes, 1991; Hayes & Hayes, 1989, 1992; Lipkens et al., 1993; Steele & Hayes, 1991) and interestingly, from our perspective, it concerns the acquisition of naming in young children. The account runs as follows: When the young child is presented with an object (Object A) and asked "what's that?" correct responses (i.e., the child saying "A") are reinforced (with smiles, etc.). This establishes the Object A → Name A relation. However, the child is also often asked "where's A?" and presented with several objects, including A. When the child selectively orients or points to A, a social reinforcer is again given, thereby training the relation Name A → Object A. Following repeated learning of object → name and name → object relations for different object-name pairs, when a new Object X → Name X relation is trained, the Name X → Object X relation emerges or is derived. Similarly, when a new Name Y → Object Y relation (i.e., hears */where's Y?/* → orients to Y) is trained, the Object Y → Name Y relation (i.e., sees Y → says "Y" in response to "what's that?") emerges. Such symmetrical responding, it is held, occurs in particular contexts, the context here being naming indicated by cues such as "what's that?" "In short, with enough instances of directly trained symmetrical responding, symmetrical responding may emerge with respect to novel stimuli in that context. That is, the extensive training history may be brought to bear by a given context and provide a basis for generalized symmetrical responding" (Hayes & Hayes, 1989, p. 168).

Although we would clearly not doubt the importance of naming in bringing about success on tests of symmetry and equivalence, this example is problematic for the relational frame account. First, there is the general problem to which we have already alluded, namely, how one can account for derived relations solely on the basis of reinforced reversals of stimulus relations. Second, in this particular case, consider what happens when, after a history of naming acquisition, a new Name Z → Object Z relation is trained: The child hears /Z/ → orients to and sees Z (trained); the child sees Z → says "Z" (emerges). However, according to relational frame theory and the notion of generalized symmetrical responding, what should emerge when the child sees Z is her *hearing* /Z/, not *saying* "Z." How the child comes to say "Z" when she sees the object and what happens to the predicted hearing /Z/ response are unavoidable questions here. To deal with these problems, Hayes and colleagues (Lipkens et al., 1993, p. 216; Steele & Hayes, 1991, p. 553) have proposed that when presented with the object and asked "what's that?" the child first hears /Z/, thereby conforming to what would be expected from relational frame theory, and then utters the name "Z." It follows from this account that when a child sees an object and emits its name (i.e., that part of the name relation that Skinner described as the tact), the utterance is not controlled by the object itself but by a hypothesized hearing response that precedes it. No rationale is presented to support this notion of children hearing names before they can utter them; it certainly does not feature in Skinner's account of verbal behavior, nor, as far as we are aware, is there any evidence in the developmental literature that this occurs. It is true that children hear their own utterances, a behavior that features prominently in our account of naming acquisition, but this occurs, of course, after they have spoken and not before, as the relational frame account requires.

Third, although the above example shows that naming acquisition cannot be described as mutual entailment, neither does it involve combinatorial mutual entailment; on both these grounds naming fails to meet the criteria for participation in a relational frame. There thus appears to be a major inconsistency at the heart of the account: Either the history involved in naming acquisition is sufficient for the child to derive a relational frame, in which case combinatorial entailment (i.e., transitivity) is not necessary for framing (see Boelens, 1994), or naming, as described, is not in the frame of coordination nor indeed in any other frame.

Far from providing a clear demonstration of how generalized symmetry is established, the paradigm case of naming serves only to raise further questions about the theoretical coherence and applicability of relational frame theory. It leaves unanswered questions about which specific learning histories give rise not only to mutual entailment but also the frame of coordination and equivalence itself. Indeed, nowhere is an example given of a history that might establish in young children or nonverbal animals any other relational frame, such as opposition or comparison, nor are there empirical data from these subjects that might support such hypotheses.

It is, of course, always a possibility that other histories, perhaps either provided to nonverbal organisms or not involving naming, might give rise to generalized symmetrical responding and hence to success on match-to-sample tests of symmetry and equivalence. This has indeed been claimed by Schusterman and Kastak (1993) in a study of a sea lion (but see above). On the other hand, according to relational frame theory, one might expect success in nonhuman animals (a) that are very closely related to the human species and (b) that have very extensive histories of reinforced reversals of relations between stimuli. Dugdale and Lowe (1990) tested this hypothesis with 2 "language-trained" chimpanzees, Sherman and Austin, that had had more extensive learning histories, including histories of reinforced reversals, than almost any other nonhuman animal (for details of their learning histories, see Rumbaugh, 1977; Savage-Rumbaugh, 1986). An extensive program of controlled experimentation was carried out using a visual-visual match-to-sample task similar to that employed by Lowe and Beasty (1987). In spite of hundreds of training and test trials, including blocks of reinforced test trials, neither of the 2 chimpanzees showed any evidence of success on tests for symmetry.

In any case, if a pigeon, a chimp, or a sea lion were to pass such tests for symmetry or equivalence, what would it tell us about (a) how they passed the test (i.e., the behavioral principles involved), (b) whether such principles also govern the performance of humans who pass equivalence tests, and (c) what, if anything, this has to do with language and naming. Within the Hayes account there is an acknowledgment that naming and verbal rules can help to form relational networks and equivalence, although this is in turn explained "on the basis of names as contextual cues for relational responses, and on the basis of derived relations formed to the names themselves" (Hayes, 1994, pp. 19–20). Thus, as was the case with Sidman's account, we may conclude that relational frame theory also allows for at least two basic kinds of equivalence (i.e., one directly contingency generated, the second rule governed or otherwise verbally controlled). If contingency-generated equivalence and related phenomena were ever reliably found in any nonverbal species, perhaps after a history of reinforced "reflexivity," "symmetry," "transitivity," "equivalence," or some combination of any or all of these, then, as Boelens (1994) has suggested, the concepts of generalized symmetry, generalized transitivity, or generalized equivalence might be invoked by way of explanation. This notion of generalization would at least be more parsimonious than the complex theoretical constructions of relational frame theory, although in order to go beyond mere redescription of the behavioral data, it would itself require explanation in terms of known or novel behavioral principles.

However, until such phenomena are reliably found (if they ever are) with other species, we are left with the findings from human subjects who pass tests of equivalence. We have shown in the early part of this paper how, in learning to name, humans learn to respond to arbitrary classes of stimuli. Simple name relations, more complex name sequences, or verbal rules are all sufficient to enable subjects to pass match-to-sample tests of equivalence. Is any other concept or principle needed to account for such behavior in humans? Has there ever been an instance of equivalence in humans that has been directly contingency generated? Until there is evidence of the latter, it would certainly be more parsimonious to adopt the naming account rather than one that must invoke the several conceptual layers of relational frame theory to explain performance on match-to-sample tests.

Equivalence, Relational Frames, and Language

According to the Hayes account, relational frames are the defining characteristic of verbal events (Hayes, 1994, p. 12). Wulfert and Hayes (1988) maintain that the symmetrical relations among stimuli established by framing provide the basis for what they term *referential meaning*. They write, "The word is a symbol for the referent and the referent is the meaning of the word because both are members of the same equivalence class. In this sense, stimulus equivalence transforms nonlinguistic conditional discriminations into semantic process" (p. 126). Similarly, Sidman has argued that stimulus equivalence is "a linguistic prerequisite" (1986, p. 226) and that "words are equivalent to their 'referents' " (Sidman et al., 1986, p. 2). He observes, "By reacting to a word as to an equivalent stimulus—the meaning of the word—a person can behave adaptively in an environment without having previously been exposed to it" (1986, p. 236). As both Hayes and Sidman have recognized here, the basis for any conception of reference or meaning is the relation of words or names to objects and events, and clearly both accounts assume that this relation is captured by the notion of equivalence. This is a questionable assumption.

Symmetry and naming. First we shall consider whether the relation between a name and the object named (i.e., the referent) is one of symmetry. The example given by Hayes of naming acquisition in the young child, which we have considered in some detail above, provides excellent evidence to the contrary. This interaction, although indeed typical of what happens as relations are established between children's utterances and their other behavior and objects in the environment, cannot be described as an example of symmetry. It is, however, consistent with the account of naming provided in the first part of this paper. The problem is to explain the fact that, having been taught to look at Object Z when she hears /Z/, the child says "Z" when she next sees the object. We propose that any account of how this novel utterance occurs must recognize, as the Hayes view of symmetry does not, the role of echoic behavior and the importance of the child learning to echo the utterances of others when asked, for example, "where's the 'Z'?" If the child echoes "Z" when she hears /Z/ in the presence of Object Z, then seeing the object will come directly to control her saying "Z." The new relation—sees Object Z, says "Z"—has emerged (see pp. 199–209, *Naming*).

Indeed, although we have concentrated so far on the acquisition of naming in childhood, at any level of analysis the assumption that the relation between names and objects is symmetrical (Dugdale & Lowe, 1990) seems, upon scrutiny, to be without foundation. We might say that "X" *refers to* or *is the name of* Object X. But we cannot, as true symmetry would demand, say the reverse, that is that Object X refers to or is the name of "X." Thus, for example, although the name "chair" refers to a class of objects with particular features, these objects either singly or in groups do not refer to the name "chair." In brief, the relation between a name and that which it names is fundamentally asymmetrical.

Sameness, meaning, and naming. The view that equivalence incorporates the concept of sameness may have helped to give rise to the notion that equivalence is a linguistic prerequisite. This is certainly clear in relational frame theory, in which the most fundamental frame is held to be that of coordination or sameness, which is said to be abstracted by the child from early language training of the kind described above and which enables new name relations to emerge. Similarly, Sidman has proposed that "sameness is a prerequisite for equivalence. Therefore . . . it is also a prerequisite for the emergence of simple meanings, vocabularies, or 'semantic correspondences' " (1986, p. 227). Further pursuing this notion, Sidman argues that subjects who show equivalence between particular words (e.g., "Route 128" on a map) and objects (e.g., the road on which they are driving) might be expected to treat them as the same (e.g., by driving their car onto the words). This does not happen, he argues, only because we learn to circumscribe or inhibit the primitive stimulus function of equivalence that would otherwise impel us to show such behavior. We really would, for example, eat the word "bread," did we not learn through experience or through rules that words, even when "equivalent" to foods, are not edible.

Thus, it is assumed in both the Sidman and Hayes accounts (a) that sameness can describe the relation between certain names and objects and also (b) that it is a prerequisite for successful performance on match-to-sample tests. But a name is never the same as the object named. To say of a chair that it is "furniture" does not entail that "furniture" *is* a chair or that furniture *is the same as* a chair. Similarly, to also call tables "furniture" does not entail that chairs and tables are the same. Although different objects with a common name (e.g., "chair") may be treated in the same manner or given a similar function (e.g., by being sat upon), as Skinner (1957, p. 87) observed, we do not behave toward the name as we do toward the named object or event. We do not sit on the printed word CHAIR when we see it, nor can we sit on the spoken word "chair." Pace Sidman, it stretches credibility to maintain that we have primitive tendencies to do so. To argue that "the referent is the meaning of the word" (Wulfert & Hayes, 1988, p. 126) or that "a computer is a 'computer' " (Hayes & Hayes, 1989, p. 169) is thus to fundamentally misconstrue word meaning and reference; any particular referent, such as a particular computer, is just one of an indefinite range of objects to which the name "computer" applies. To even claim that that class of objects "is the meaning" of the word "computer" is laden with further logical and conceptual problems (Hunter, 1974; Ryle, 1949; Skinner, 1957, pp. 86–89).

We believe that the account of naming acquisition presented in the early part of this essay avoids many of these pitfalls. It does not view names as being the same as the objects or events named or as being equal to them, nor does it consider that objects are part of names or even part of the meaning of names. Naming is behavior and, like any other behavior, it occurs in relation to objects and events but it is not to be confused with them. To blur this distinction or, indeed, to remove it entirely (see Sidman, 1994, p. 386) is to introduce myriad problems. We have already shown how the young child learns a name (e.g., "furniture") that relates to a class of objects (e.g., chairs, tables, etc.) that are physically disparate. The child's use of the conventional name "furniture" for each of these objects establishes the conventional stimulus class and governs her use of each class member (e.g., the placing of it in a dolls' house). It is this behavior, or as Wittgenstein would have it, the *use* of naming in "the actions into which it is woven" (Wittgenstein, 1953, p. 5, 1972, p. 170), that gives rise to what equivalence researchers and others have termed *semantic relations, referential meaning,* and *vocabularies* (see pp. 213–215, *Naming and Symbolic Behavior*).

Sameness and equivalence. As for sameness being a prerequisite for equivalence, if a subject, using the common name "furniture" on a match-to-sample task, is shown to have established an equivalence class of chairs, tables, and chests of drawers (or their pictures), this clearly does not mean that the relation formed was one of sameness. Nor, of course, does it mean that because they were in an equivalence relation, the chair was the name of a table or that either was the name of a chest of drawers. To take an example from the experimental literature, when stimuli within experimenter-defined classes in match-to-sample experiments are abstract shapes (e.g., a triangle, a green square, and a vertical line), there is no reason to assume that any of the visual stimuli themselves are treated by the subject as being the *same as,* or indeed the *name of,* any other stimulus; intraverbal naming (e.g., "up-green-triangle") or verbal rules (e.g., "goes with") that have nothing to do with the concept of sameness may be operating.

Further experimental evidence that subjects do not invariably treat stimuli within an equivalence class as the same or equally substitutable comes from studies conducted by Fields and colleagues (Adams, Fields, & Verhave, 1993; Fields, Adams, & Verhave, 1993). These have shown that such stimuli can occasion very different kinds of behavior (e.g., as indicated by reaction-time measures, errors in test trials, transfer of novel responding within the class, and within-class stimulus preferences) depending upon their distance from the nodal stimulus and the direction of training of the stimulus relations. Thus, although according to the logico-mathematical criteria of stimulus equivalence, stimuli may appear to be related to each other on the basis of equality (Sidman, 1990), more detailed analysis of behavior reveals substantial differences in subjects' responses to them (Fields et al., 1993).

In defense of Sidman's account, it should be noted that, in his critique of relational frame theory (Sidman, 1994, p. 559), he has argued that equality is only one example of an equivalence relation. Equivalence, he maintains here, is more general and includes relations such as "is parallel to" and "is congruent to" (for triangles in a plane) and "has the same teacher as." This view, however, raises further questions, namely, (a) how can it be reconciled with the position that sameness is a "prerequisite for equivalence" (Sidman, 1986, p. 227), and (b) given that it is not the formal characteristics of the stimuli that determine performance on the equivalence test, how does a nonverbal organism or an organism behaving nonverbally acquire such relations as "has the same teacher as"?

Equivalence and rule-governed behavior. According to both Sidman and Hayes, rule-governed behavior is based upon equivalence relations, and this, they believe, deals with one of the shortcomings of Skinner's account, that is, that it does not provide a behavioral specification of how rules "specify" contingencies. As Sidman has observed, "If equivalence gives rise to rules, then for a rule to specify a contingency may simply mean that the rule and the contingency are members of an equivalence class" (1990, p. 106; see Devany et al., 1986; Hayes & Hayes, 1992). What is not clear from either the Sidman or Hayes accounts, however, is how rules and contingencies can be members of the same equivalence class or how such a relation could come about. For, in the same way that we have demonstrated that names and objects are not symmetrically related, it can be shown that the relation between rules and contingencies is not one of either symmetry or equivalence. Under certain circumstances verbal rules, perhaps acquired by instructions from others, govern behavior but this behavior does not govern the verbal rules. Indeed, although there may be an interaction, it is a well-established finding that rules can be remarkably insensitive to the consequences of the behavior they govern (Catania et al., 1982; Lowe, 1979, 1983). It makes sense to talk, as Skinner does, of rules that describe or specify contingencies but not of contingencies that specify or describe rules. Thus, it is not the case that rules are the "same as" or "equal to" contingencies, or, as Sidman (1994) would have it, that the distinction between rules and contingencies, like that between other responses and stimuli, breaks down if both participate in an equivalence class (p. 386). There is, on the contrary, a great deal of experimental evidence showing major differences between contingency-shaped and rule-governed behavior (Lowe, 1979, 1983) that is entirely consistent with Skinner's observation that

> If cognitive psychologists were correct in saying that rules are *in* the contingencies, it would not matter whether we learned them from the contingencies or from the rule—in other words, from acquaintance or description. The results, however, are obviously different. . . . There is a difference because rules never fully describe the contingencies they are designed to replace. There is also a difference in the states of the body felt. (1989, pp. 43–44)

So once again, there is the danger that the notion of equivalence may mask rather than clarify crucial behavioral distinctions. In using the terms *describe* and *specify* for the relation of rules to contingencies, Skinner may have been closer to the mark than his critics were. Nevertheless, it must be conceded that these terms do require more precise behavioral specification, and it is this that we have aimed to achieve here. Certainly, little progress will be made in understanding how rules come to govern behavior until we understand the role of the verbal units of which rules are composed, how they come into being and how, either individually or in combination, they affect other behavior. This has so far not been attempted in the equivalence literature and although we have attempted to lay the foundations for such an understanding, there is clearly much more to be done before a comprehensive analysis can be provided.

Summary. From the evidence presented in this section there are a number of conclusions that can be drawn on the relation between equivalence and language. (a) The relation between name and objects is not one of symmetry or equivalence. The fact that subjects pass match-to-sample tests cannot be taken to indicate that sameness is involved in their behavior; nor can we assume that the members of an equivalence class are the names of other members, or refer to, symbolize, or mean them. Although match-to-sample performance and the construct of equivalence cannot provide a model for linguistic behavior it may, however, be diagnostic of its effects, that is, success on symmetry and equivalence tests may be a good indicator that the subject has acquired naming.

The Construct of Stimulus Equivalence: Do We Need It?

Problems with the unitary concept of equivalence. We have shown that success on match-to-sample tests, and thus, according to its operational definition, stimulus equivalence, can be established by several different behavioral routes, including common naming, intraverbal naming, and more complex verbal rules such as "A goes with B," "A is the same as B," and so on. It has also been suggested, as a theoretical possibility, that there might be a type of equivalence that is directly contingency generated. But these various paths to success represent very different behavioral processes that, although they may yield the common outcome of correct performance on a particular match-to-sample configuration, may have other differing behavioral outcomes including, we predict, different performances on tests of stimulus class extension. Evidence to this effect comes from a study by Bentall et al. (1993), who have shown that adults taught a common name for stimuli later related in a match-to-sample task showed no reaction-time differences to the stimuli on baseline, symmetry, transitivity, and equivalence trials. When, however, subjects were taught individual stimulus names rather than common names, they showed longer reaction times on the transitivity and equivalence trials than on the symmetry and baseline trials. These results indicate that although, where meeting the mathematical criteria for equivalence is concerned, the behavior of subjects with common naming may differ little from that of those with intraverbal or other strategies, when other measures such as reaction times are recorded, there is evidence of behavioral differences (Adams et al., 1993; Fields et al., 1993).

Different verbal repertoires can have the common function of generating success on equivalence tests, and it is easy to see how this fact could have given rise to usage of a common term, *stimulus equivalence,* to describe this success and to a belief in a correspondingly new phenomenon. What has not until now been appreciated, however, is that success on stimulus equivalence tests may be a secondary and indirect outcome of more varied and fundamental verbal processes. Most researchers in this area, although ostensibly investigating the "new" phenomenon of stimulus equivalence, may in fact have been studying naming and other forms of verbal behavior, but under a different name. Their tendency to ignore the possible role of subjects' verbal behavior and hence not even to record it (but see Dugdale & Lowe, 1990; Saunders & Spradlin, 1990; Wulfert et al., 1991) may have led many researchers to overlook significant variables that influence test outcome. This seems to be a good example of what Skinner (1969) has termed the *formalistic fallacy* (see also Vygotsky, 1978, p. 62), whereby an undue emphasis is placed upon the formal characteristics of behavior (e.g., success on equivalence tests) at the expense of an analysis of controlling relations (e.g., the role of verbal stimuli).

Whether or not subjects succeed on equivalence tests is not a matter of a straightforward logical or mathematical relation but rather of a behavioral process that varies with a number of factors. These include whether the subject produces names in ways that will generate stimulus class categories in line with those specified by the experimenter. And this in turn, as we have seen, is determined by a variety of other factors including whether the procedure is audio-visual or visual-visual, whether names are provided directly by the experimenter or generated by prior history of stimulus classification, and, of course, whether the names thus generated control the appropriate listener behavior of pressing the corresponding response keys. If we are interested in establishing the determinants of human match-to-sample performance, future research should explore these relations in detail.

Given, as other investigators have also suggested, that the existing mathematical approach to defining equivalence is problematic (Pilgrim & Galizio, 1995; Saunders et al., 1993; Saunders & Green, 1992), as are attempts to characterize it in terms of simple notions such as sameness, one way forward might be to create a new definition. We suggest, however, that the flight to logico-mathematical models is a diversion from the central task of conducting a functional analysis of the conditions that give rise to success on matching tests so that these definitional issues can be resolved, including the question of whether a definition of stimulus equivalence is required at all. If success on tests of stimulus equivalence is indeed a by-product or secondary outcome of naming and other verbal processes, the very notion of a "generalized concept of equivalence" (Johnson & Sidman, 1993, p. 346) begins to evaporate. As we have shown, we do not need it to account for the success of human subjects on match-to-sample tests or to account for the range of other emergent behavior that occurs during early language development in the child. Indeed, the arbitrary match-to-sample procedure itself (as distinct from identity matching), particularly visual-visual matching, is a highly artificial set of circumstances of a sort infrequently, if ever, encountered by most children and thus is an odd experimental paradigm upon which to base a general understanding of new or derived relations or language itself.

Are theories of equivalence necessary? As we have attempted to show, arbitrary stimulus classes, upon which the concept of stimulus equivalence is based, are a fundamental aspect of the name relation, hence the relevance of equivalence research for the analysis of verbal behavior. But is the notion of *stimulus equivalence* a helpful explanatory device or does it introduce conceptual confusion? Stimulus equivalence, as originally defined, describes a set of behavioral relations on match-to-sample tasks. To label these behavioral outcomes as *equivalence, symmetry,* or *relational frames* and then to use these constructs to account for the behavior from which they were derived together with a range of other linguistic and transfer-of-function phenomena requires justification. One negative effect may be that, in erecting an elaborate set of abstractions upon this limited behavioral base, a false sense of security is created and it is concluded that language acquisition, verbal rules and, of course, *derived* stimulus classes themselves have been explained.

A more serious difficulty arises, however, when theoretical constructs introduce conceptual confusion and impede research. Again we have indicated how some constructs in the equivalence literature might have this effect. For example, in order to account for naming, are any or all of the following constructs from relational frame theory required: arbitrarily applicable relational responding, relational frames, the frame of coordination, mutual entailment, combinatorial mutual entailment, transformation of stimulus function, and equivalence? Or are any or all of the Sidman hypotheses required? His theory also views naming as being derived from the construct of equivalence but in an even more complex manner, with much of the theoretical effort (see Sidman, 1994, pp. 389, 554) invested in explanations of why equivalence does not occur rather than in a functional analysis of how both it and naming come about.

As Skinner (1950) pointed out, another problem with some kinds of theory is that when the theory is overthrown, much of the associated research is discarded. This has happened once before with a research enterprise that was based on the notion of equivalence and that also claimed that equivalence was at the center of linguistic behavior (Jenkins, 1965). The search for the key to equivalence failed then, the theory faded away, and the research seems, indeed, to have been largely forgotten. This time around, should not our research enterprise deal directly with verbal behavior itself unmediated by the construct of equivalence? Verbal behavior will not fade away.

To study naming directly entails, as we have indicated, the experimental investigation, from birth, of how the young child learns the individual behavioral relations that in combination bring about naming. This approach would certainly be more parsimonious; it is also in the best tradition of behavior analysis. Such a study would enable researchers to come to terms with the full complexity of the phenomenon, both in terms of the conditions that give rise to it and the interactions between multisensory stimulation and multimodal responding that it entails, including emotional behavior and the effects of classical conditioning. Such complexity cannot be encompassed by the logico-mathematical abstractions of equivalence.

It is researchers' recognition of the importance of emergent behavior that has been responsible for much of the interest in stimulus equivalence. The present account suggests that their work on the latter should now lead to examination of the variables that are responsible for bringing about "new" behavior and the direct study of language acquisition and its effects on other behavior. In switching the focus of research from what may appear to many to be an arcane phenomenon called *stimulus equivalence* to phenomena such as naming and its relation to categorization, we can make common ground with other researchers both in psychology and other disciplines who themselves recognize these latter areas of inquiry as valid and important. Furthermore, we are likely to enhance the practical applications of research in the field. Instead of assuming that emergent behavior comes about as a result of an innate unanalyzable stimulus relation best revealed in the match-to-sample paradigm, practitioners will advance towards understanding how language itself emerges and how it can be used to foster the development of stimulus classes and, hence, an almost infinite range of new behavior.

Reconciling the Different Accounts

Although in the foregoing we have stressed the differences between our account and those of Sidman and Hayes, all three accounts share common ground. First, there is the recognition that it is important to establish how subjects, without having been directly trained to do so, can in some contexts treat structurally different stimuli as if they were interchangeable, that is, as members of a stimulus class. Second, there is the conviction that the phenomena studied are closely bound up with linguistic behavior. In view of these central similarities, might not the differing accounts be reconciled in order to advance a common research agenda for the future? Perhaps one way of achieving this reconciliation would be to recognize that there might be at least two ways that a subject could achieve success on an equivalence test, that is, by way of either directly contingency-generated behavior or rule-governed or verbally controlled behavior. The principles underlying the former might not be clear, but it would be an empirical question as to whether it does or does not occur. If it could not be found (e.g., in nonverbal species or nonverbal infants) then perhaps all three accounts would have to accept that we must deal with a verbally driven phenomenon. The question then would become how to account for the verbal behavior.

This focus would help to remove some of the other incompatibilities. For example, one aspect of Sidman's (1994) recent account that seems most likely to be contentious and difficult to reconcile with our view is the notion that basic learning phenomena, such as Pavlovian conditioning and conditioned reinforcement, are derived from stimulus equivalence. But if equivalence is verbally driven and occurs only in humans, then the notion that naming enters into the establishment of classical conditioning effects and conditioned reinforcement would not be at all problematic; indeed, there is considerable experimental evidence to support such a view (e.g., Sokolov, 1972). That said, we would, nevertheless, have to maintain that these conditioning phenomena are not invariably derived from naming or equivalence but, indeed, are among the true behavioral primitives that give rise to verbal behavior and stimulus classes in humans.

Shifting the emphasis to verbal behavior should also help to establish a greater compatibility between the Hayes account and our own. Both accounts assume that the phenomena of interest come about as a result of a learning history, which even in the Hayes account is recognized as "lying largely in the context of language training" (Steele & Hayes, 1991, p. 20). Relational frame theory sees the repeated reinforcement of relations between stimulus pairs and their reversals as sufficient, whereas we maintain that, in addition to the stimuli presented, what the child says, what she hears, and the listener behavior thus engendered are all critical elements in acquisition of the crucial repertoire. Thus, the accounts are similar in their general emphasis on learning history, although they carry different implications for how naming should be taught and how it enters into relations with other behavior. Nevertheless, it should be possible to submit the different hypotheses to experimental test on this issue so that a common basis could be established from which to move forward. If, of course, it was found that very young infants, prior to experiencing either of the kinds of history proposed in this or in the Hayes account, could readily form equivalence classes, which in turn facilitated acquisition of naming, then both the present account and that of Hayes would need to be revised in line with Sidman's theory. We have reviewed the existing evidence bearing on these issues in earlier sections, and the reader can judge accordingly, but much of the critical experimentation remains to be done.

CONCLUSION

The starting point for the present paper has been Skinner's account of verbal behavior, which, although central to his thinking, has not had nearly the impact or recognition within psychology and other disciplines that many, including the present authors, maintain that it deserves (Andresen, 1990; Richelle, 1993). Much of the important research on children's language acquisition conducted in recent years, for example, makes extensive use of operant methods and experimental techniques but ironically draws little from Skinner's interpretation of verbal behavior. Part of the aim of the present paper is to add to Skinner's exposition in ways that will demonstrate the merits of a behavioral perspective. Although we have concentrated upon how naming, the most basic verbal unit, comes about during the first 2 years of life, our approach and method could be extended to account for the full range of linguistic behavior.

Our main contribution, we believe, has been to add to Skinner's description of speaker behavior an account of the speaker as listener. As we have tried to show, the fusion of speaker and listener behavior within the individual has profound and far-reaching consequences, transforming the basic verbal relations identified by Skinner (i.e., the tact, mand, and intraverbal) so that each becomes a variant of the basic name relation. The result is the creation, within each name, of bidirectional or closed-loop relations between a class of sometimes physically very different objects or events and the speaker-listener behavior it occasions. The name relation is both the focal point of this achievement, where all these events are brought together, and at the same time the means of further dynamic interchange between them, giving rise to the range of emergent and symbolic behavior we have described, including what has been termed *verbal thinking, reference, meaning, rule governance,* and *human consciousness.* Referring to the special accomplishments of verbal behavior, Skinner (1957) says that the speaker is "a locus—a place in which a number of variables come together in a unique confluence to yield an equally unique achievement" (p. 313). We would add that it is only when the speaker becomes a speaker-listener and can name that this unique achievement is realized.

An effective behavioral theory of language acquisition should be of benefit not just outside the behavior-analytic tradition but also within, because, as some have argued (e.g., Richelle, 1993), the topic, centrally important though it is, has so far not received adequate attention from behavior analysts themselves. As we have stressed, the account presented here is a theoretical one, and the particular behavioral relations we have outlined, beginning with listener behavior and moving on to the echoic and finally naming, appear to us to provide the necessary behavioral conditions for the acquisition of naming. But this account, together with a range of related issues, needs to be experimentally validated. To do so requires a systematic program of developmental behavioral research.

There are a number of issues that such research should address. For example, we have indicated the primacy of listener behavior in the naming acquisition sequence (at least until the establishment of higher order name relations); this indeed appears to be generally true for young children who have no sensory impairment, but there is evidence that children who do have sensory impairments (i.e., who are deaf or blind) may often learn speaker behavior before they learn the corresponding listener behavior relating to particular objects and events (Mulford, 1988; Pettito, 1992). Whatever the particular sequence of acquisition, we maintain that for naming to occur it is necessary for conventional listener and speaker repertoires to combine, and we have proposed that it is echoic responding, either overt or covert, in the presence of objects or events that is critical in bringing this about. However, this possibility remains to be empirically validated. Even in the case of children without sensory impairments, it may be informative in this regard to investigate forms of naming other than speaking, such as signing or other coding responses (see Lowenkron, 1984, 1988, 1989; Sundberg & Sundberg, 1990).

It is also necessary to investigate the role of reinforcement provided by the verbal community in establishing and maintaining these behavioral relations. The related issue of covert behavior and stimuli, including reinforcing stimuli, and the development of a covert verbal repertoire also require detailed research because, as Skinner (1957, pp. 434–438) has observed, such repertoires constitute so much of what is called human thinking. There are, however, complex methodological issues that must be dealt with if covert events are to be studied effectively in behavioral research (Lowe, 1983), not least in the study of stimulus equivalence. There are, in addition, many issues concerning the role of naming in bringing about stimulus classes and functional transfer of behavior across stimulus classes. Because theories of stimulus equivalence that are not based on naming have hitherto been dominant within behavior analysis, research on the pivotal role of naming in such behavior has hardly begun.

The present account also has implications for attempts to teach language to nonhuman animals and to establish clear criteria against which such efforts can be assessed. It indicates that the central focus of such training should be upon establishing in the subjects a fusion of listener and speaker repertoires such as is established in the young child. Clearly, the more that can be learned about the conditions that bring about this latter development, the better equipped will be the researchers who embark upon these projects. The critical tests of whether success in establishing naming has been achieved are those that we have already outlined. To date there is no convincing evidence that any nonhuman animal has passed tests of this kind.

The importance of studying verbal behavior was made clear by Skinner (1987) who wrote, "The human species took a crucial step forward when its vocal musculature came under operant control in the production of speech sounds. Indeed, it is possible that all the distinctive achievements of the species can be traced to that one genetic change" (p. 79). In our attempt to advance this study we have focused upon the earliest forms of verbal behavior, showing how children learn to name objects and events. In so doing, our account provides the prerequisite basis for an analysis of other more elaborate verbal forms, including complex propositions, sentences, and grammar. We have also furnished a theoretical basis for understanding a range of interactions between verbal and nonverbal behavior that are of great practical import, heretofore studied under the various guises of rule-governed behavior, verbal control, correspondence training, and stimulus equivalence (see Lowe, 1979, 1983; Lowe et al., 1987). An understanding of the role of naming and other verbal behavior within all these domains represents an exciting challenge for future research.